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1   **4.0 WASTE DESCRIPTION**

2   This chapter describes the type of waste that *is emplaced and* will be emplaced in the Waste

3   Isolation Pilot Plant (WIPP) and provides an appraisal of the inventory of physical, chemical,

4   and radionuclide components of the waste. This information supports the development of the

5   performance assessment *(PA)* models that are used in predicting the long-term behavior of the

6   repository. This chapter includes a waste description based on the inventories of existing and

7   projected waste reported *for the CCA (1996a) reported* in the transuranic (TRU) Waste Baseline

8   Inventory Report (TWBIR) (included in ~~this application as~~ *CCA* Appendix BIR) *and updated*

9   *for CRA-2004 in Appendix DATA, Attachment F. This chapter also includes* a description of

10   the projected waste inventory, waste limits derived from both the ~~performance assessment~~ *PA*

11   and operational safety and health considerations, and methods of control to ensure compliance

12   with the identified waste limits. ~~In addition~~*Finally*, this chapter provides a discussion of the

13   applicable qualitative and quantitative waste characterization methodologies.

14   *Inventory estimates provided in the CCA (Appendix BIR) represented the information*

15   *available at that time. It was anticipated that WIPP waste inventory estimates would change*

16   *as the U.S. Department of Energy (DOE) characterized the contents of waste containers prior*

17   *to shipment to WIPP and as new TRU wastes were generated. Data on emplaced waste and*

18   *updated estimates of the entire projected waste inventory are provided in Appendix DATA,*

19   *Attachments D, E, F and H. The waste-inventory estimates reported in Appendix DATA and*

20   *in this chapter are based on the available information as of September 30, 2002, unless*

21   *otherwise noted.*

22   *Objectives of this chapter are to:*

23   *1. Report quantities and characteristics of the waste emplaced in the repository since*
24   *certification;*

25   *2. Describe the current understanding of the WIPP waste inventory (emplaced, stored,*
26   *and projected waste) in terms of waste components and characteristics;*

27   *3. Update waste inventory information for PA and compliance assessment calculations;*

28   *4. Reassess waste components and characteristics and associated waste-emplacement*
29   *limits that may be important to long-term repository behavior; and*

30   *5. Identify changes or new information related to the WIPP waste characterization*
31   *program that have occurred since certification.*

32   ~~Title 40 of the Code of Federal Regulations (CFR) §~~ *Section* 194.24(a) *of 40 CFR Part 194*

33   specifies that the ~~U.S. Department of Energy (DOE)~~ shall provide information pertaining to the

34   chemical, radiological, and physical composition of the waste planned to be emplaced in the

35   repository. Specifically, the criterion states

36   Any compliance application shall describe the chemical, radiological and physical composition
37   of all existing waste proposed for disposal in the disposal system. To the extent practicable, any
38   compliance application shall also describe the chemical, radiological and physical composition of

1   to-be-generated waste proposed for disposal in the disposal system. These descriptions shall
2   include a list of waste components and their approximate quantities in the waste. The list may be
3   derived from process knowledge, current non-destructive examination/assay, or other information
4   and methods.

5 This waste description includes the definition, sources, types, components, and characteristics of
6 ~~TRU~~ *the* waste planned for emplacement in the WIPP. The description provided in this chapter,
7 along with the waste characterization analysis in ~~Appendix WCA~~[1] *Appendix TRU WASTE,*
8 *Section TRU WASTE-2.0*, identifies those physical, chemical, and~~/or~~ radiological components
9 of the waste that may singly or in combination affect the ability of the WIPP disposal system to
10 meet the environmental performance standards contained in ~~40 CFR~~ Part 191. This chapter is
11 supported with several appendices. For example, waste related parameters used in ~~performance~~
12 ~~assessment~~ *PA* are discussed in ~~Appendix PAR and Appendix WCA~~ *Appendix PA, Attachment*
13 *PAR and Appendix TRU WASTE, Section TRU WASTE-2.0.* Results of sensitivity analyses
14 with respect to total releases used to generate the mean complementary cumulative distribution
15 function (CCDF) in Section 6.5 are discussed in ~~Appendix SA~~ *Appendix PA.* The impact of
16 waste components and characteristics on WIPP performance is discussed in ~~Appendix WCA~~
17 *Appendix TRU WASTE, Section TRU WASTE-2.0.* Limits for waste components are discussed
18 in *CCA* Appendix WCL*; and in Appendix TRU WASTE, Section TRU WASTE-3.0* and
19 summarized in this chapter. ~~(See Table 1-4 in Chapter 1.0 for a list of appendices that provide~~
20 ~~additional information supporting this chapter.)~~ This chapter also ~~describes~~ *summarizes*
21 methods of control that will be employed by the DOE to ensure that only those wastes that are
22 consistent with ~~these descriptions~~ *those on which the PA is based* are actually emplaced in the
23 repository. One such control is the WIPP Waste Information System (WWIS) ~~(DOE 1995e~~
24 ~~1996b)~~ database for controlling the receipt of and tracking the emplacement of waste (see
25 Section 4.3.2).

26 Before the final ~~performance assessment~~ *PA for the CCA* was designed, *DOE performed* waste
27 characterization analyses ~~comprised of~~ *based on* iterative preliminary ~~performance assessment~~
28 *PA*s, related sensitivity analyses, and dedicated process studies for specific components and
29 characteristics of the waste~~, were performed~~. A list of waste components and characteristics that
30 were considered during these analyses, the list of and rationale for the ones retained for inclusion
31 in the final ~~performance assessment~~ *PA*, and the ones not included are documented in *CCA*
32 Appendix WCL. *This process has been updated for this recertification application (CRA-*
33 *2004); waste components and characteristics retained for CRA-2004 PA are documented in*
34 *Appendix TRU WASTE, Section TRU WASTE-2.0.* Retained waste components are assigned
35 fixed values in the final ~~performance assessment~~ *PA* (see Appendix ~~PAR~~ *PA, Attachment PAR*)
36 based on information reported in ~~the TWBIR, Revision 3 (Appendix BIR)~~ *Appendix DATA,*
37 *Attachment F*. Therefore, during the ~~performance assessment~~ *PA*, plausible combinations of
38 fixed values for waste components are included in all ~~performance assessment~~ *PA* scenario
39 analyses. Important imprecisely known waste characteristics are ~~provided~~ *assigned* ranges and
40 distributions (*see* ~~See Appendix SOTERM and Appendix PAR~~ *Appendix PA*) from which values
41 are drawn using a Latin hypercube sampling (LHS) technique that ensures that samples are taken
42 from across the entire range of the distribution (*see* ~~See~~ Section 6.1.5.2).

---

[1] ~~The waste characterization analysis detailed in Appendix WCA was peer reviewed per the criteria in 40 CFR §~~
~~194.27(a)(2). Results of this peer review are documented in Section 9.3.2 and in Appendix PEER.~~

1 Since results demonstrate compliance with the quantitative containment requirements in ~~40 CFR~~
2 ~~§~~ *Section* 191.13, the individual protection requirements in ~~40 CFR §~~ *Section* 191.15, and the
3 groundwater protection requirements in ~~40 CFR §~~ *Section* 191.24, the fixed values used for
4 waste components define a profile of waste suitable for disposal at WIPP. Following the final
5 ~~performance assessment~~ *PA for the CCA*, sensitivity analyses determined the contribution of
6 uncertainty in individual input variables to the uncertainty in model predictions (that is, final
7 releases). *In that sensitivity analysis, there* ~~There are~~ *were* no waste characteristics that ~~have~~
8 *had* a significant impact on the uncertainty about and the location of the mean CCDF reported in
9 *CCA* Figure 6-39 (~~See~~ *see CCA* Appendix SA for a discussion of this uncertainty). Therefore,
10 setting waste component limits is not based on ~~performance assessment~~ *PA* results but is based
11 on ensuring the validity of repository conditions modeled by ~~performance assessment~~ *PA* (~~See~~
12 *see CCA* Appendix WCL). *The same is true for the CRA-2004.* In addition, the limits are
13 repository-scale limits ~~that should be met~~ *applicable to the inventory* at the time of ~~repository~~
14 decommissioning. The process for demonstrating compliance with these limits is to track the
15 waste-component quantity and the uncertainty associated with that quantity as waste is emplaced
16 in the repository. For example, the curie content for plutonium *(Pu)* and ~~it's~~ *its* uncertainty
17 (based on the fact that a large percentage of the waste has yet to be generated) can be
18 accumulated as waste is emplaced throughout the operational phase. Then, at the time of
19 decommissioning, when these repository limits apply, the total curie content for ~~plutonium~~ *Pu*
20 may be provided with a specified level of confidence, such as 95 percent, to demonstrate
21 compliance with the waste component limits.

22 Figure 4-1 illustrates the information flow pertaining to the waste description and its relationship
23 to other sections of this chapter as well as Chapter 6.0 and appendices to this application.

24 **4.1   Waste Inventory**

25 The waste inventory is defined as the quantity of waste that is anticipated to be emplaced in the
26 WIPP *and that waste that is already emplaced*. This inventory is generally characterized as the
27 nonradionuclide inventory that consists of both physical and chemical waste constituents,
28 generally expressed in units of density or concentration *(kg/m^3)*; and the radionuclide inventory,
29 which is a tabulation, by specific isotope, of anticipated radionuclides in the waste expressed in
30 units of curies *(Ci)*.

31 The term TRU waste is defined (~~EPA 1993~~) *in the WIPP Land Withdrawal Act (LWA) (Public*
32 *Law 102-579 as amended by Public Law 104-201)* as

33   waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes *per gram of*
34   *waste*, with half-lives greater than 20 years, ~~per gram of waste,~~ except for (A) high-level
35   radioactive waste~~s~~; (B) waste that the *Secretary* ~~Department~~ has determined, with the concurrence
36   of the Administrator, does not need the degree of isolation required by *the disposal regulations*
37   ~~this part~~; or (C) waste that the *Nuclear Regulatory* Commission has approved for disposal on a
38   case-by-case basis in accordance with *part 61 of title* 10, *Code of Federal Regulations*. ~~CFR Part~~
39   ~~61.~~

40 ~~TRU isotopes have atomic numbers greater than uranium (92). In determining the alpha-activity~~
41 ~~concentration levels for waste classification, only the mass of the waste is used in the~~
42 ~~concentration calculation. The waste container, plus any added shielding and other packaging, is~~
43 ~~not included in the mass component of this determination.~~
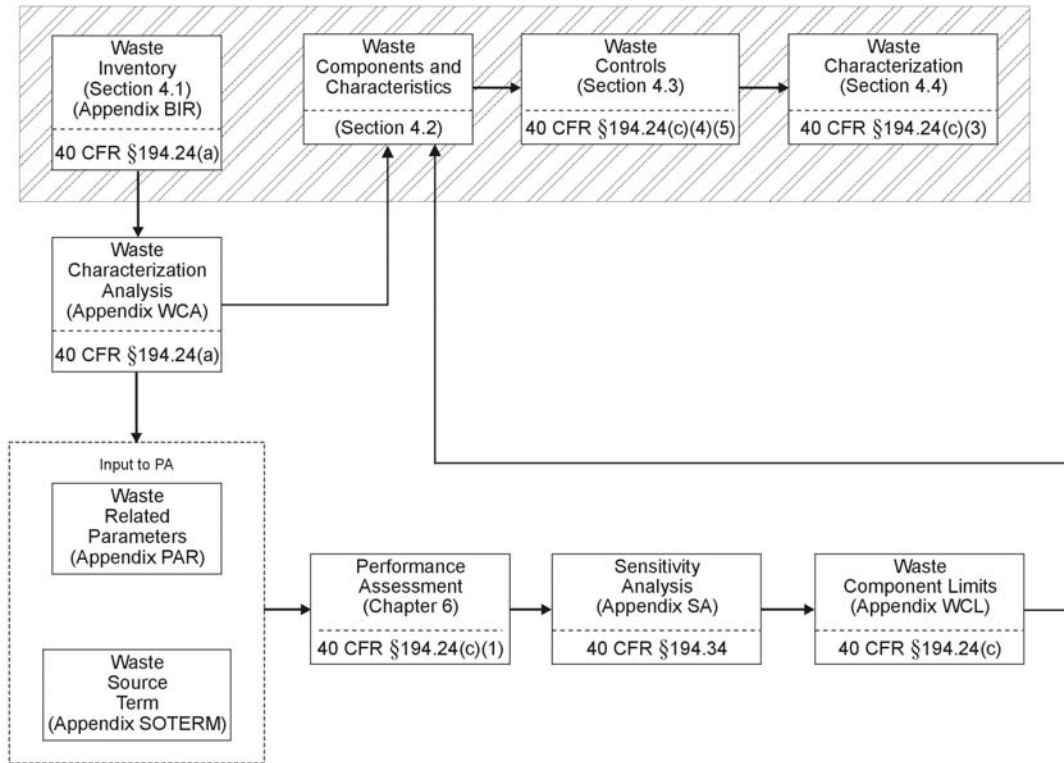
CCA-173-0

Figure 4-1. Waste Description Information Flow

3 ~~Pre-1970~~ TRU waste that ~~has been~~*was* disposed of ~~by generators~~ in on-site, shallow landfill-type
4 configurations *prior to the early 1970s* is referred to as buried waste. In 1970, the U.S. Atomic
5 Energy Commission concluded that TRU waste should ~~have greater confinement from the~~
6 ~~environment~~*be stored in anticipation of the creation of more confining disposal facilities*.
7 ~~Thus,~~ TRU waste generated since that date has been segregated from other waste types and
8 placed in retrievable storage. Waste generated after ~~the early 1970s~~*1970*, but before
9 implementation of ~~the DOE's TRU~~ *CBFO certified waste quality assurance (QA) program*
10 ~~Waste Characterization Quality Assurance Program Plan (QAPP)~~, is referred to as retrievably
11 stored waste. Waste generated after a site's implementation of ~~the~~*CBFO certified QA program*
12 ~~QAPP~~ is defined as newly generated. *These and other relevant terms are defined in Appendix*
13 *DATA, Attachment F.* ~~TRU waste (DOE 1995b). Implementation of the QAPP occurs after the~~
14 ~~site's Quality Assurance Project Plans (QAPjPs) have been approved and implemented.~~

15 Newly generated waste will be characterized in a similar manner to retrievably stored waste, but
16 it will incorporate more real-time, as opposed to historical, acceptable knowledge. *As of*
17 *September 30, 2002, approximately* ~~Approximately~~65 percent of the waste to be disposed of at
18 the WIPP ~~is~~ *was* expected to be newly generated waste, as described in the TWBIR (*CCA*
19 Appendix BIR). *At the time of the data call for CRA-2004 (September 30, 2002),*
20 *approximately five percent of the waste DOE plans to dispose in the WIPP had been emplaced*
21 *in the repository. Approximately 73 percent of the waste to be disposed of in the WIPP is*
22 *classified as retrievably stored waste, approximately 22 percent of the waste identified by the*
23 *TRU waste sites to be disposed of at the WIPP is expected to be newly generated waste (see*
24 *Appendix DATA; Attachment F).*

1
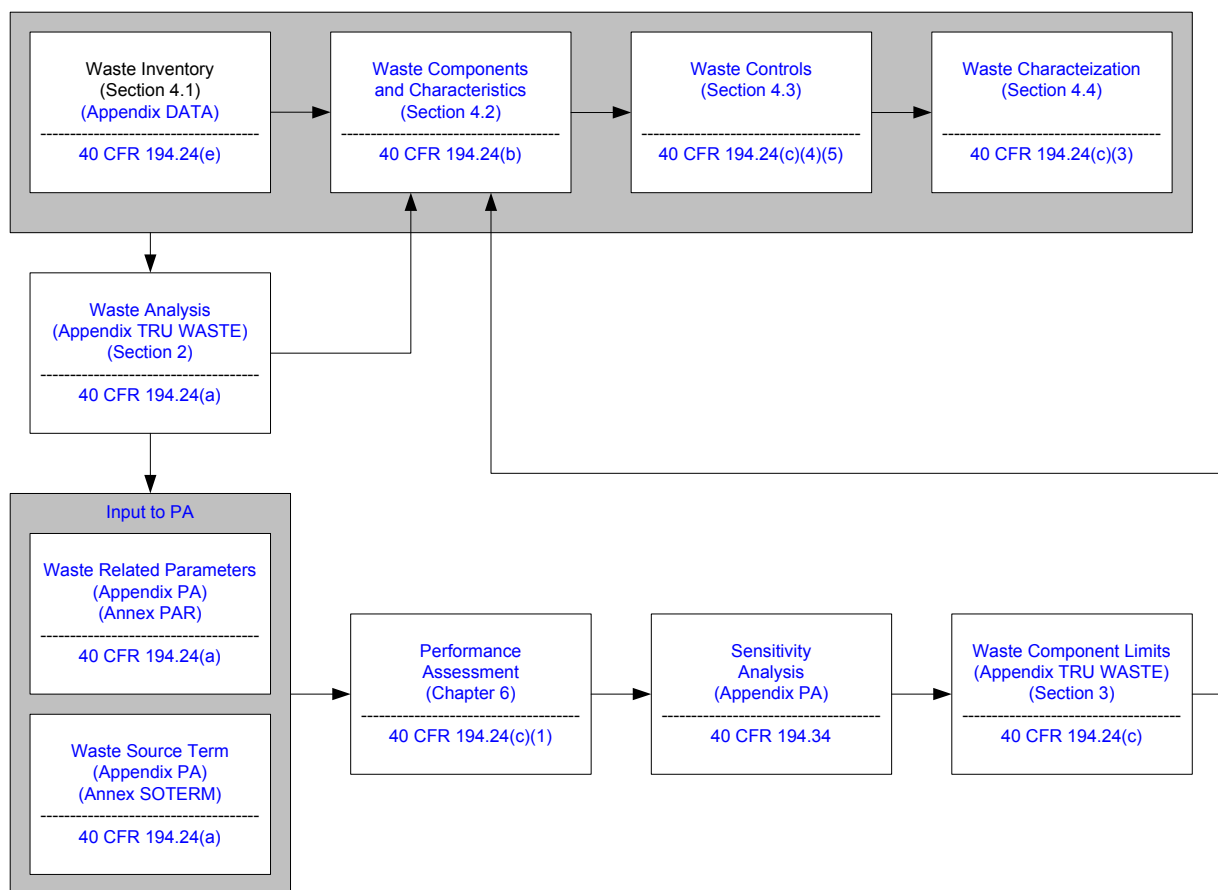
2 **_Figure 4-1. Waste Description Information Flow_**

3 TRU waste is classified as either contact-handled (CH) or remote-handled (RH) based on the
4 contact dose rate at the surface of the waste container. If the contact dose rate is less than ~~or~~
5 ~~equal to~~ 200 millirem per hour (2 milliSievert per hour), the waste is defined as CH-TRU (DOE
6 1988). If, on the other hand, the contact dose rate is greater than **_or equal to_** 200 millirem per
7 hour (2 milliSievert per hour), the waste and its container are defined as RH-TRU (DOE 1988).
8 **_Consistent with the LWA, o_**~~O~~nly RH-TRU waste less than or equal to 1000 rem per hour (10
9 Sievert per hour) is eligible for disposal at the WIPP ~~(DOE 1996a)~~. **_Also, t_**~~T~~o meet the
10 requirements as set forth in the ~~WIPP Land Withdrawal Act (LWA) (U.S. Congress 1992b)~~, the
11 total ~~combined volumes of CH-TRU~~ ~~and RH-TRU waste are not to exceed~~**_capacity of WIPP by_**
12 **_volume is_** 6.2 million ~~cubic feet~~ **_ft³_** (175,564 ~~cubic meters~~ **_m³_**) **_of TRU waste_**. Moreover, the
13 LWA also specifies that the emplaced RH-TRU waste is not to exceed a total activity of 5.1
14 million ~~curies~~ **_Ci_** (~ 18.9×10^{16} Becquerel) and a total activity concentration of 23 ~~curies~~ **_Ci_** per
15 liter **_maximum activity level_** (averaged over the volume of the canister). No more than five
16 percent of the emplaced RH-TRU waste may exhibit a dose rate in excess of 100 rem per hour (1
17 Sievert per hour).

18 ~~The last category of waste to be defined is TRU mixed waste, that is, waste that contains both~~
19 ~~TRU radioactive components and hazardous components as defined in the New Mexico~~
20 ~~Administrative Code (see NMAC in the Bibliography). Hazardous components of TRU mixed~~
21 ~~waste to be managed at the WIPP facility are designated in Part A of the WIPP Resource~~

1 ~~Conservation and Recovery Act (RCRA) permit application. The Waste Analysis Plan (WAP)~~
2 ~~(see Appendix WAP) describes measures to ensure that the wastes received at the WIPP facility~~
3 ~~are within the scope of the Part A. As stated in Appendix WCA (Section WCA.4.1.3), only four~~
4 ~~of 60 organic compounds in the waste are expected to have an effect on actinide mobility. None~~
5 ~~of the four (acetate, citrate, oxalate, and ethylenediaminetetracetate [EDTA]) are listed in Part A~~
6 ~~of the WIPP RCRA permit application. Consequently, this component of TRU waste is omitted~~
7 ~~from further discussion in this chapter.~~

8 ### 4.1.1   Sources of TRU Waste

9 The DOE's TRU waste, as described in this chapter, is derived primarily from ~~plutonium~~ *Pu*
10 fabrication and ~~re~~processing, research and development (R&D), decontamination and
11 decommissioning (D&D), and environmental restoration (ER) programs at ~~various~~ *DOE* sites.
12 Most TRU waste generated at the ~~DOE~~ *TRU waste* sites results from specific processes and
13 activities that are well defined and well controlled, enabling ~~the DOE~~ *the sites* to characterize the
14 waste on the basis of acceptable knowledge ~~of~~*concerning* the process, input ~~raw~~ materials, and
15 ~~output~~ finished products. Some examples of these operations include

16 • Production of nuclear products. Production of nuclear products includes reactor
17   operation, radionuclide separation and finishing, and weapons fabrication and
18   manufacturing. The majority of the TRU waste was generated by weapons fabrication
19   and radionuclide separation and finishing processes. More specifically, wastes typically
20   consist of TRU-contaminated material derived from chemical processes, air and liquid
21   filtration, casting, machining, cleaning, product quality sampling, analytical activities,
22   and maintenance and refurbishment of equipment and facilities.

23 • ~~Plutonium~~ *Pu* recovery. ~~Plutonium~~ *Pu* recovery wastes are TRU-contaminated items and
24   materials from the recovery of valuable ~~plutonium~~ *Pu*, including contaminated molds,
25   metals, glass, plastic~~s~~ *materials*, rags, salts used in electrorefining, precipitates, firebrick,
26   soot, and filters.

27 • R&D. R&D projects include a variety of hot-cell or glove-box activities that often
28   simulate full-scale operations described above, producing similar TRU wastes. Other
29   types of R&D projects include metallurgical research, actinide separations, process
30   demonstrations, and chemical and physical properties determinations.

31 • D&D. Facilities and equipment that are no longer needed or usable are decontaminated
32   and decommissioned, resulting in TRU wastes consisting of scrap materials, cleaning
33   agents, tools, piping, filters, ~~p~~*P*lexiglas, gloveboxes, concrete rubble, asphalt, cinder
34   blocks, and other building materials. This is expected to be the largest category by
35   volume of TRU waste to be generated.

36 • *ER Programs. The implementation of environmental restoration programs at various*
37   *DOE sites results in the generation of a variety of materials including contaminated*
38   *soil, building materials and equipment.*

1   Operations carried out in glove boxes and hot cells generate both combustible and
2   noncombustible wastes. Combustible waste contains mixtures of paper, plastics *materials*, rags,
3   cloth clothing, and wood resulting from ~~plutonium~~ *Pu* operations. Cloth and paper wipes are
4   used to clean parts and glove boxes. Depending on the operations, damp combustibles are
5   usually used and then wrung out, drained, or dried. Noncombustibles consist primarily of glass
6   and metal. Much of this waste is laboratory equipment and glassware from R&D activities.

7   Filters are sometimes combinations of combustibles and non-combustibles and come from a
8   variety of sources including high-efficiency particulate air (HEPA) filters, filter media, processed
9   filter media, and prefilters. Prefilters and HEPA filters are used on all ventilation intake and
10   exhaust systems associated with ~~plutonium~~ *Pu* operations. Filter frames can be either wood,
11   aluminum, or stainless steel; and the filter media may be paper, Fiberglass, Nomex, or similar
12   material. Filter media are generated from splitting absolute dry box and HEPA filters apart from
13   their frames in the ~~plutonium~~ *Pu* process areas. Loose particulate materials that are dislodged
14   from the filters are stabilized and packaged separately from the media. Filter media are
15   packaged in plastic bottles or bags. Filter media may also be mixed with portland cement to
16   neutralize any residual nitric acid.

17   Graphite waste is produced from molds that are broken, cleaned, or scraped in glove boxes to
18   remove excess ~~plutonium~~ *Pu*. Graphite is a uniform, well-defined material.

19   Benelex and Plexiglas are well-defined materials that are used as neutron shielding material and
20   in glove-box construction. Benelex consists mainly of cellulose with residual amounts of the
21   phenolic resin. Plexiglas is a polymethyl methacrylate polymer used for glove-box windows and
22   is generated as waste during the change-out of the glove-box windows.

23   Inorganic process solids include residues from evaporator and other types of storage tanks, grit,
24   firebrick fines, ash, salts, metal oxides, and filter sludge. This waste is typically solidified in
25   portland- or gypsum-based cements.

26   Soil, asphalt, and sand contaminated from spills or generated from D&D activities may also be
27   present in the waste.

28   To isolate the radiological and hazardous ~~co~~-contaminants of these wastes from humans and the
29   environment during handling and other life-cycle operations, a primary confinement barrier is
30   used. Both CH-TRU and RH-TRU waste at the WIPP facility will be managed using payload
31   containers that meet the requirements of the U.S. Department of Transportation (DOT) for Type
32   A or equivalent containers (DOE 1995~~d~~*c*). The term payload container in this document refers to
33   drum, drum overpack, canister, standard waste box, or ten-drum overpack unit. Internal to these
34   payload containers may be other secondary layers of confinement, including rigid plastic inner
35   liners and multiple layers of plastic bagging. Each container is vented using one or more filters.

36   *4.1.2   TRU Waste ~~Generator and Storage~~ Sites*

37   The major ~~generator and storage~~ *TRU waste* sites *(referred to as large quantity sites [LQSs])*
38   ~~(see Figure 4-2)~~ that are *in the process of shipping or are* planning to ship their TRU waste to
39   the WIPP for disposal include

Note: Adapted from Figure 1-1, TWBIR Vol. 1.

1
2 **Figure 4-2. ~~U.S. DOE TRU Waste Generator and Storage Sites~~**

3 • ~~Richland~~ Hanford *Richland* ~~Site (HANF)~~ *(Hanford-RL); TRU wastes at Hanford under*
4 *the purview of the DOE Richland Operations Office*

5 • *Hanford River Protection (Hanford-RP); TRU wastes at Hanford under the purview of*
6 *the DOE Office of River Protection*

7 • Idaho National Engineering *and Environmental* Laboratory (INE*E*L)

8 • ~~Lawrence Livermore National Laboratory (LLNL)~~

9 • Los Alamos National Laboratory (LANL)

10 • ~~Nevada Test Site (NTS)~~

11 • Oak Ridge National Laboratory (ORNL)

12 • Rocky Flats Environmental Technology Site (RFETS)

13 • Savannah River Site (SRS)

14 *Since certification, Lawrence Livermore National Laboratory (LLNL) and the Nevada Test*
15 *Site (NTS) have been recategorized as small quantity sites (SQSs). In addition, TRU waste at*
16 *the Hanford Reservation has been divided into two categories: (1) TRU waste overseen by the*
17 *DOE Richland Operations Office (Hanford-RL) which corresponds to the TRU waste reported*
18 *by Hanford for the CCA inventory estimate, and (2) TRU waste overseen by the DOE Office of*
19 *River Protection (Hanford-RP). The DOE Office of River Protection may send both CH-TRU*

1 *and RH-TRU waste to the WIPP. The Hanford-RP waste was not included in the Hanford*
2 *Reservation waste reported for the CCA but is included in the 2004 CRA. The inventories for*
3 *the SQSs and LQSs are reported in Appendix DATA, Attachment F, Annex J.*

4 *At the time of the CCA,* ~~The~~ INE*E*L, LANL, and RFETS *were* ~~are~~ expected to be among the first
5 of the major ~~generator and storage~~ *TRU waste* sites to begin shipping TRU waste to the WIPP.
6 *As of September 30, 2002, the WIPP had received 1,255 shipments totaling 7,716 m^3 (2.7 × 10^5*
7 *ft^3) of CH-TRU waste, primarily from INEEL, LANL, and RFETS. SRS and Hanford-RL*
8 *have also made shipments. Emplaced, stored, and projected waste volumes, by TRU waste site,*
9 *are provided in Tables 4-1 and 4-2. No RH-TRU waste has yet been shipped to the WIPP.*

10 **Table 4-1. Emplaced, Stored, and Projected CH-TRU Waste Inventory as of**
11 **September 30, 2002[1]**

TRU Waste Site	Emplaced CH-TRU Volume (m^3)	Stored CH-TRU Inventory (m^3)	Projected CH-TRU Inventory (m^3)	Disposal CH-TRU Inventory[3] (m^3)
Hanford-RL	9.8×10^1	1.3×10^4	1.3×10^4	4.1×10^4
Hanford-RP	0.0×10^0	3.9×10^3	0.0×10^0	3.9×10^3
INEEL	2.9×10^3	6.1×10^4	1.2×10^2	6.4×10^4
LANL	2.7×10^2	1.2×10^4	3.3×10^3	1.9×10^4
ORNL	0.0×10^0	0.0×10^0	4.5×10^2	9.5×10^2
RFETS	4.3×10^3	5.4×10^3	2.7×10^3	1.5×10^4
SRS	2.0×10^2	1.3×10^4	2.4×10^3	1.8×10^4
SQS[2]	0.0×10^0	1.2×10^3	2.8×10^3	7.1×10^3
Totals	7.7×10^3	1.1×10^5	2.5×10^4	1.7×10^5

Source: Appendix DATA; Attachment F.

[1] Volume reported by the TRU waste sites as of September 30, 2002. It is not scaled to the disposal volume.

[2] Includes currently identified SQSs; at some TRU waste sites, determinations that waste is generated through defense activities have yet to be made. Inventories for those TRU waste sites are not included in this number.

[3] This is the TRU waste site inventory scaled as follows: emplaced + stored + 2.11 (projected).

13 As ~~the other major~~ *TRU waste* sites develop the prerequisite certification programs required for
14 TRU waste disposal at the WIPP, they too will commence shipping waste to the WIPP.
15 Effective implementation by the ~~generator and storage~~ *TRU waste* sites of ~~the~~ DOE ~~Carlsbad~~
16 ~~Area Office (CAO)~~ Quality Assurance Program Document (QAPD) (see *CCA* Appendix QAPD)
17 is a prerequisite for granting TRU waste certification authority to the *TRU waste* sites. A letter
18 granting such authority will specify the date that the subject *TRU waste* sites effectively
19 implemented their characterization and certification program. Any limitations imposed on the
20 certification authority will be described in the letter.

21 *As part of the certification for the project (63 FR 27404), the EPA promulgated a new section*
22 *to the rule, Title 40 CFR 194.8. Section 194.8 establishes the approval process that must be*
23 *completed before an individual TRU waste site may ship waste to the WIPP. The EPA*
24 *approval considers the application of QA provisions to the waste-characterization process,*
25 *including EPA audits or inspections DOE audits of TRU waste site waste-characterization*

1   *Table 4-2. Stored and Projected RH-TRU Waste Inventory as of September 30, 2002[1]*

TRU Waste Site	Stored RH-TRU Inventory (m^3)	Projected RH-TRU Inventory (m^3)	Disposal RH-TRU Inventory[3] (m^3)
Hanford-RL	3.8×10^2	9.4×10^3	2.0×10^3
Hanford-RP	4.5×10^3	0.0×10^0	4.5×10^3
INEEL	2.2×10^2	0.0×10^0	2.2×10^2
LANL	1.2×10^2	0.0×10^0	1.2×10^2
ORNL	0.0×10^0	6.6×10^2	1.1×10^2
RFETS	0.0×10^0	0.0×10^0	0.0×10^0
SRS	0.0×10^0	2.3×10^1	4.0×10^0
SQS[2]	9.5×10^1	3.3×10^2	1.5×10^2
Totals	5.3×10^3	1.0×10^4	7.1×10^3

Source: Appendix DATA; Attachment F.
[1]   *Volume reported by the TRU waste sites as of September 30, 2002. It is not scaled to the disposal volume.*
[2]   *Includes currently identified SQSs; at some TRU waste sites, determinations that waste is generated through defense activities have yet to be made. Inventories for those TRU waste sites are not included in this number.*
[3]   *This is the TRU waste site inventory scaled as follows: emplaced + stored + 0.172 (projected)*

2   **programs, and provides for public review and comment. Section 194.8 also applies to the**
3   **application of process knowledge by the TRU waste sites for waste characterization. The DOE**
4   **must also implement a system of controls at the TRU waste sites to confirm that the total**
5   **amount of each waste component emplaced in the disposal system will not exceed established**
6   **limiting values.**

7   **Current information on the EPA approval of TRU waste sites to ship waste to WIPP consistent**
8   **with the requirements of section 194.8 is provided in Table 4-3. In addition to these TRU**
9   **waste sites, the Central Characterization Project (CCP) has been initiated by DOE and**
10   **operates using mobile waste characterization equipment. As of September 30, 2003, CCP was**
11   **operating and approved to ship waste from SRS, Argonne National Laboratory – East (ANL-**
12   **E), and Nevada Test Site (NTS).**

13   *Table 4-3. Approved TRU Waste Site QA and Waste Characterization Programs as of*
14   *September 30, 2002*

TRU Waste Site
Hanford-RL
INEEL
LANL
RFETS
SRS

Source: WWIS

In addition to the major ~~generator and storage~~ ***TRU waste*** sites, there are currently numerous ~~small-quantity sites~~ (SQSs) planning to dispose TRU waste at the WIPP. Options to facilitate disposal of the SQS waste at the WIPP include either direct shipment to the WIPP after on-site characterization and certification or shipment to an interim ~~site~~***facility*** for performing waste consolidation, treatment, and/or characterization and certification in accordance with WIPP requirements. The current list of SQSs ***that plan to ship directly to WIPP or to a larger site pending shipment to WIPP*** includes***:***

- ~~Ames Laboratory~~

- Argonne National Laboratory – East ***(ANL-E),***

- Argonne National Laboratory – West ***(ANL-W),***

- Battelle Columbus Laboratories ***(BCL),***

- Bettis Atomic Power Laboratory ***(BAPL),***

- Knolls Atomic Power Laboratory ***(KAPL),***

- ***Knolls Atomic Power Laboratory-Nuclear Fuel Services (KAPL-NFS),***

- ***Lawrence Berkeley National Laboratory (LBNL),***

- ***Lawrence Livermore National Laboratory (LLNL),***

- ~~Massachusetts Institute of Technology~~

- ~~National Institute of Standards and Technology~~

- ***Nevada Test Site (NTS),***

- Paducah Gaseous Diffusion Plant ***(PGDP)***,

- Sandia National Laboratories/NM (SNL)***, and***

- ~~Site A/Plot M (near Chicago, Illinois)~~

- U.S. Army Material Command ***(USAMC).***

As waste-management plans evolve at these TRU waste sites, the list is expected to change. Some TRU waste sites, for example, may ship waste to alternate facilities for processing pending shipment to WIPP. However, as of September 30, 2002, plans for shipment to alternate facilities had not been finalized. The inventories for these SQSs are reported in Appendix DATA, Attachment F, Annex J.

Six SQSs have shipped their waste to an LQS. These include:

- ***ARCO Medical Products Company (ARCO) – Shipped to LANL,***

1   • Energy Technology Engineering Center *(ETEC) – Shipped to Hanford-RL,*

2   • Mound Plant *– Shipped to SRS,*

3   • ~~University of~~ Missouri University Research Reactor *(MURR) – Shipped to ANL-E,[2]*

4   • Pantex Plant *- Shipped to LANL, and*

5   • Teledyne Brown Engineering *– Shipped to RFETS.*

6   *The inventories for these several SQSs are included in the LQS inventories.*

7   *Several SQSs plan to ship waste to WIPP, but their waste had not been determined to be*
8   *defense waste as of September 30, 2002. These include:*

9   • *Babcock & Wilcox – Nuclear Engineering Services (B&W-NES),*

10   • *Brookhaven National Laboratory (BNL),*

11   • *Framatome,*

12   • General Electric Vallecitos Nuclear Center *(GE-VNC),*

13   • ~~Special~~ *Separations* Process Research Unit *(SPRU), and*

14   • West Valley Demonstration Project *(WVDP).*

15   *The inventories for these SQSs are reported in Appendix DATA, Attachment F, Annex I.* ~~As~~
16   ~~more SQSs are identified, they will be added to this list.~~

17   ~~Figure 4-2 shows the geographic locations of the major generator and storage sites.~~

18   *4.1.3   TRU Waste Inventory*

19   A summary of the quantity of stored and projected TRU waste and TRU waste components is
20   contained in ~~the TWBIR (see Appendix BIR)~~ *Appendix DATA, Attachment F*. ~~The TWBIR~~
21   *Appendix DATA, Attachment F* documents *DOE's current understanding of* the total inventory
22   of ~~DOE~~ TRU waste and includes both the TRU waste that is planned to be disposed at the WIPP
23   site and the TRU waste that ~~will not~~*is not planned to* be sent to WIPP *as of September 30, 2002*.
24   Only the WIPP portion of the TRU waste inventory is used in ~~performance assessment~~ *PA*
25   calculations that support the development of *CRA-2004* ~~this compliance application~~.

26   *In preparing CRA-2004, DOE initiated a "data call" to obtain current waste inventory*
27   *information from its TRU waste sites similar to the data call that was conducted prior to 1995*
28   *in preparation for the CCA. Each TRU waste site was asked to review previous data submitted*

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[2] Shipment of MURR waste to ANL-E occurred after September 30, 2002.

1   *regarding its TRU waste and revise those data based on current knowledge of waste at the*
2   *TRU waste site.*

3   *The results of the "data call" were compiled in a database called the Transuranic Waste*
4   *Baseline Inventory Database (TWBID) Revision 2.1. Data from the TWBID are reported in*
5   *detail in Appendix DATA, Attachment F and are summarized here. For the CCA, there were*
6   *essentially two categories of waste: stored waste and projected waste (see CCA Section 4.1.3.1*
7   *for definitions). For CRA-2004, there are three categories of waste: emplaced waste, stored*
8   *waste, and projected waste (see Section 4.1.3.1 for definitions).*

9   For the DOE to consider disposal system performance at full capacity, it *is*was necessary to scale
10 the waste volumes reported by the *TRU waste* sites in the TWBIR. This is because the *volume*
11 *identified by the TRU waste sites is less than the available volume of the repository, 175,564*
12 *m^3 (6.2 million ft^3)* TWBIR does not identify 6.2 million cubic feet (175,564 cubic meters) of
13 existing or projected waste. The projected inventory *reported by the TRU waste sites* in the
14 TWBIR is scaled if needed, to achieve a disposal limit *inventory* equal to the design limit
15 *repository volume specified by the WIPP LWA*. *The repository volume remains unchanged.*
16 For RH TRU waste volume, the TWBIR identified a sufficient quantity of retrievably stored
17 waste, such that scaling is not required for WIPP's RH TRU waste disposal limit of 250,000
18 cubic feet (7,079 cubic meters).

19 *As of September 30, 2002, the TRU waste sites reported a total CH-TRU waste stored*
20 *inventory of 1.1×10^5 m^3 (3.9×10^6 ft^3) and a total RH-TRU waste stored inventory of 5.3 ×*
21 *10^3 m^3 (1.9×10^5 ft^3) (see Tables 4-1 and 4-2). This is DOE's current estimate of the stored*
22 *inventory destined for WIPP. In addition to identified stored volumes, the TRU waste sites*
23 *project that an additional 2.5×10^4 m^3 (8.8×10^5 ft^3) of CH-TRU waste and 1.0×10^4 m^3 (3.5 ×*
24 *10^5 ft^3) of RH-TRU waste will be generated in the future.*

25 *The stored CH-TRU waste inventory currently reported by the TRU waste sites is larger than*
26 *the same inventory reported in the CCA. SRS, RFETS, Hanford, and INEEL all reported*
27 *increased stored CH-TRU volumes based on new information about their waste and increased*
28 *accessibility to the waste. The Hanford-RP waste was not included in the previous Hanford*
29 *estimate used in the CCA, although the TWBIR indicated that it might be included in the*
30 *WIPP inventory at some time in the future. Several SQSs (BCL, BAPL, KAPL, and PGDP)*
31 *have identified small inventories of CH-TRU stored waste since the CCA was submitted.*

32 *While the TRU waste sites are reporting larger quantities of CH-TRU waste in storage, they*
33 *are reporting smaller quantities of CH-TRU waste in the projected category. The shift from*
34 *reporting waste as stored rather than projected reflects progress at the TRU waste sites*
35 *towards cleanup and closure.*

36 *Overall, the anticipated CH-TRU waste inventory (stored plus projected) remaining for*
37 *disposal at WIPP has decreased by an amount that is essentially equivalent to the inventory of*
38 *CH-TRU waste emplaced in the repository. The total inventory (emplaced plus anticipated) of*
39 *CH-TRU waste is less than the disposal limit of 168,485 m^3. Therefore, for PA calculations,*
40 *the CH-TRU waste projected inventory is scaled to produce a disposal inventory equal to the*
41 *repository limit.*

1   *The stored RH-TRU waste inventory currently being reported by the TRU waste sites*
2   *represents an increase in the stored RH-TRU waste inventory reported in the CCA inventory*
3   *estimate. Hanford-RP and Hanford-RL both reported more stored RH-TRU waste based on*
4   *new information about it and increased accessibility to the waste. ANL-E, BAPL, and SNL*
5   *added small amounts of stored RH-TRU waste to their inventories. ORNL moved all of their*
6   *RH-TRU waste into the projected waste category because they plan to process the waste using*
7   *segregation, size reduction, and evaporative drying. As its entire RH-TRU waste inventory*
8   *will be processed, the ORNL RH-TRU waste is reported only as a projected inventory.*

9   *While the stored RH-TRU estimates have increased in the CRA-2004, the projected RH-TRU*
10 *inventory estimates for CRA-2004 are less than what they were in the CCA inventory estimate.*
11 *The greatest decrease in projected RH-TRU waste inventory was reported by Hanford-RL.*
12 *The TRU waste sites report a decrease in the anticipated (stored plus projected) RH-TRU*
13 *waste inventory for disposal at WIPP, a drop from over 2.6×10^4 m^3 (9.2×10^5 ft^3) reported in*
14 *the CCA to about 1.0×10^4 m^3 (3.5×10^5 ft^3) as of September 30, 2002.*

15 *Nevertheless, the anticipated volume of RH-TRU reported for the CRA-2004 is greater than*
16 *the repository limit for RH-TRU. Therefore, for PA calculations, the RH-TRU projected*
17 *inventory is scaled down so the total disposal volume of RH TRU equals the repository limit of*
18 *$7,079$ m^3 (2.5×10^5 ft^3).*

19 ~~Although updates are made to the TWBIR based on new information received from ongoing~~
20 ~~waste identification and characterization activities at the generator and storage sites, the TWBIR~~
21 ~~is an inventory report and not a summary of TRU waste characterization data. For waste shipped~~
22 ~~to the WIPP, waste characterization data associated with each container are entered into the~~
23 ~~WWIS for tracking purposes. A description of the WWIS is given in Section 4.3.2.~~

24 In support of ~~performance assessment~~ *the CCA PA*, it was necessary for ~~the~~ DOE to roll-up
25 waste information on a repository scale. To this end, the TWBIR describes a process for
26 grouping individual waste streams with similar physical and chemical properties into waste
27 profiles, based on the waste matrix code (WMC) assigned by ~~the~~ DOE TRU waste ~~generator and~~
28 ~~storage~~ sites. *The same process was followed for CRA-2004 (see Appendix DATA, Attachment*
29 *F and Appendix TRU WASTE, Section TRU WASTE-2.0).* Waste profiles with similar WMCs
30 are ~~then~~ combined across the DOE TRU waste system to provide estimated total volumes and
31 total waste material parameters (WMPs). WMPs and waste components (as used in ~~40 CFR §~~
32 *Section* 194.24) are synonymous. Individual waste streams are evaluated to estimate the
33 occurrence and quantities of ~~nonradioactive~~ WMPs (for example, cellulosics *materials*, ~~plastics,~~
34 iron-base metal and alloys, etc.) and are identified in *Appendix TRU WASTE, Section TRU*
35 *WASTE-2.0* ~~Appendix WCA~~ as having either a significant or negligible effect on the
36 performance of the WIPP repository. ~~See Table 4-1 for a listing of these waste components and~~
37 ~~their associated characteristics.~~

38

1 **Table 4-1. Waste Characteristics and Components That are Expected to Have Significant**
2 **and Negligible Effects**

Characteristic	Component	Effect on Performance
Characteristics and Components Expected to Have a Significant Effect		
radioactivity in curies of each isotope	radioactivity in curies of each isotope	used in calculation for normal release
TRU radioactivity at closure	á-emitting TRU radionuclides, $t_{1/2} >$ 20 years	determines waste unit factor
solubility	radionuclides	actinide mobility
colloid formation	radionuclides, cellulose, soils, plastics, rubber	actinide mobility
redox state	radionuclides	actinide mobility
redox potential	ferrous metals	actinide oxidation state; actinide mobility
gas (H_2) generation	ferrous metals	increase in H_2 pressure
microbial substrate: CH_4 generation	cellulose	increase in gas pressure
microbial substrate: CH_4 generation	plastics, rubber	increase in gas pressure
particle diameter	solid waste components	spalling release
microbial nutrients: CH_4 generation	sulfates	increase in gas pressure
microbial nutrients: CH_4 generation	nitrates	increase in gas pressure
compressibility and shear strength	solid waste components	effect on creep closure, cuttings, caving, spalling
Characteristics and Components Expected to Have a Negligible Effect		
permeability	solid waste components	negligible effect on brine movement, gas storage
porosity	solid waste components	negligible effect on brine movement
microbial nutrients, CO_2 generation	sulfates	negligible: MgO reacts with CO_2
microbial nutrients, CO_2 generation	nitrates	negligible: MgO backfill reacts with CO_2
microbial substrate: CO_2 generation	cellulose	negligible: MgO backfill reacts with CO_2
microbial substrate: CO_2 generation	plastics, rubber	negligible: MgO backfill reacts with CO_2
gas generation	water in the waste	enhances initial gas generation

3 4.1.3.1 Inventory Terminology

4 *The following definitions are provided to help clarify the information contained in this*
5 *chapter. Most of the definitions from the CCA have been included in this section without*
6 *change. For CRA-2004, some definitions have been refined and others have been added.*

7 *Anticipated waste inventory – The sum of the stored and projected TRU waste inventories at*
8 *DOE TRU waste sites that have not been emplaced at WIPP.*

9 As-Generated Waste – The chemical and physical status of waste when it is generated. The as-
10 generated term applies to both stored and ~~future~~ *projected* waste.

1 *Disposal Inventory – The volume used for CRA-2004 PA calculations. The LWA sets the total*
2 *amount of TRU waste allowed in the WIPP at 175,564 m^3 (6,200,000 ft^3).*

3 *The "Agreement for Consultation and Cooperation" limits the RH-TRU inventory to 7,079 m^3*
4 *(250,000 ft^3) (DOE/NM 1981).*

5 ~~Disposal Inventory – The inventory volume defined for WIPP emplacement to be used for~~
6 ~~performance assessment calculations is the disposal inventory. The LWA defines the total~~
7 ~~amount of TRU waste allowed for disposal in the WIPP as 6.2 million cubic feet (175,564 cubic~~
8 ~~meters) (U.S. Congress 1992b). Consistent with 40 CFR § 194.24(g), this is the maximum~~
9 ~~quantity of TRU waste which will be emplaced in the repository. The WIPP limit of RH-TRU~~
10 ~~inventory is 250,000 cubic feet (7,079 cubic meters), as set by the Consultation and Cooperation~~
11 ~~Agreement between the DOE and the state of New Mexico (DOE and state of New Mexico~~
12 ~~1981).~~

13 *Emplaced waste inventory – Waste that has been placed in the repository as of September 30,*
14 *2002.*

15 *Final Waste Form – The expected physical form of a waste stream. The use of the final waste*
16 *form helps to group waste streams that are expected to have similar physical and chemical*
17 *properties at the time of disposal. Waste is assigned to one of 11 final waste forms: solidified*
18 *inorganics, salt, solidified organics, soils, uncategorized metal, lead/cadmium metal, inorganic*
19 *non-metal, combustible, graphite, heterogeneous, and filter.*

20 ~~Final Waste Form – The final waste form of a waste stream consists of a series of WMCs that are~~
21 ~~grouped together, which for performance assessment purposes have similar physical and~~
22 ~~chemical properties. The final waste form applies to both stored and projected inventory. Table~~
23 ~~4-2 presents anticipated WMCs for TRU waste and indicates the final waste form typically~~
24 ~~assigned to each WMC for the TWBIR. There are 11 final waste forms used in the TWBIR.~~
25 ~~Each of the 11 final waste forms described in Table 4-2 identify a material property common to~~
26 ~~the numerous waste streams grouped under it.~~

27 *September 30, 2002 (the inventory date) – The date used for determining the emplaced waste*
28 *inventory included in CRA-2004 and the date TRU waste sites have used as the basis for their*
29 *revised inventory estimates.*

30 Projected Inventory – The part of the TRU inventory that has not been generated but is ~~currently~~
31 estimated to be generated at some time in the future by the TRU waste ~~generator and storage~~
32 sites~~, is known as projected inventory~~. The projected inventory is the same as the to-be-
33 generated waste referred to in ~~40 CFR §~~ *Section* 194.24(a).

34 Stored Inventory – *Also referred to as "retrievably stored" inventory.* The part of the
35 *anticipated waste inventory stored in such a fashion that it can be readily retrieved.*
36 *Retrievably stored waste includes waste stored at the TRU waste sites since the early 1970s in*
37 *buildings or berms with earthen cover and does not include waste generated prior to 1970.*
38 *Retrievably stored waste also includes waste in underground storage tanks, ponds, and as*

39

1 **Table 4-2. WMCs and Their Anticipated Final Waste Form**

Final Waste Form	WMCs
Solidified Inorganics	L1000, L1100, L1110, L1120, L1130, L1140, L1190, 1200, L1210, L1220, L1230, L1240, L1290, S3000, S3100, S3110, S3111, S3112, S3113, S3115, S3118, S3119, S3120, S3121, S3122, S3123, S3124, S3125, S3129, S3130, S3131, S3132, S3139, S3144, S3150, S3160, S3190, S3900, X6000, X6200, X6300, X6400, X6900, X7300, X7500, X7510, X7520, X7530, X7590, L9000, Z1110, Z1190
Salt	S3000, S3140, S3141, S3142, S3143, S3149, S3900, L9000
Solidified Organics	L2000, L2100, L2110, L2120, L2190, L2200, L2210, L2220, L2290, L2900, S3000, S3114, S3200, S3210, S3211, S3212, S3219, S3220, S3221, S3222, S3223, S3229, S3230, S3290, S3900, S5340, X6000, X6100, X6190, X6900, L9000, Z1110, Z1190
Soils	S4000, S4100, S4200, S4300, S4900
Uncategorized Metal (Metal Waste Other Than Lead and/or Cadmium)	S3116, S5000, S5100, S5110, S5111, S5119, S5190, X6200, X7000, X7290, X7400, X7430, X7490, X7520, Z1140, Z1190, Z2100
Lead and Cadmium Metal	S5000, S5100, S5110, S5112, S5113, S5119, S5190, X6220, X7000, X7200, X7210, X7211, X7212, X7219, X7220, X7290, X7400, X7410, X7420, X7490, Z2100
Inorganic Nonmetal	S3117, S3118, S3160, S5000, S5100, S5120, S5121, S5122, S5123, S5124, S5125, S5126, S5129, S5190, Z1120, Z1150, Z1190
Combustible	S5000, S5300, S5310, S5311, S5312, S5313, S5319, S5320, S5330, S5390, Z1130, Z1190, Z1200
Graphite	S5000, S5126
Heterogeneous	S5000, S5100, S5400, S5420, S5440, S5450, S5460, S5490, X7520, Z2900
Filter	S5000, S5410

Source: Adapted from TWBIR, Revision 3, Table 2-1.
+ WIPP is limited to 7079 cubic meters of RH TRU waste.

2 *decontamination and decommissioning material identified for disposal that requires retrieval*
3 *at the TRU waste sites.*

4 Scaling – The process of adjusting, if needed, the projected inventory to the design *repository*
5 limit (disposal inventory) is called scaling. Scaling is needed in performance assessment *PA* to
6 model the WIPP repository at full capacity (6.2 million cubic feet *ft^3* by statute *as set by the*
7 *LWA*). *The scaling factor used in the CRA-2004 for CH-TRU waste is 2.11. This is only*
8 *applied to the projected component of a waste stream. The scaling factor for RH-TRU waste is*
9 *0.172, which is also only applied to the projected component of a waste stream.*

10 Based on the inventory identified in Revision 3 of the TWBIR, the scaling factor is calculated to
11 be 2.05 (see Appendix BIR [Revision 3, 2-3]).

12 Stored Inventory + Projected Inventory (2.05) = Disposal Inventory

13 *Scaled Inventory – Synonymous with disposal inventory. The scaled inventory is the volume*
14 *that fills WIPP capacity and is used for PA calculations. This volume is calculated as the sum*
15 *of the disposal volumes for all WIPP-eligible waste streams after application of RH-TRU*
16 *waste and CH-TRU waste scaling computations to each WIPP-eligible projected TRU waste*
17 *stream.*

WIPP Waste Inventory – The sum of the emplaced waste inventory and the anticipated waste inventory.

Waste Characteristic – Section 194.2 defines waste characteristic as a property of the waste that has an impact on the containment of waste in the disposal system.

Waste Component - Section 194.2 defines waste component as an aspect of the total inventory of the waste that influences a waste characteristic.

Waste Matrix Codes (WMCs) – Codes developed by DOE, in response to the Federal Facility Compliance Act (~~U.S. Congress 1992a~~ *Public Law 102-386*), ~~as a methodology~~ to aid in categorizing mixed waste streams in the DOE system into a series of five-digit alphanumeric codes (for example, S5400; Heterogeneous Debris) that represent different physical and chemical matrices. Using guidance prepared by ~~the~~ DOE (DOE 1995~~f~~*e*), the WMC is assigned by the TRU waste ~~generator and storage~~ sites for all mixed waste streams and ~~some~~ unmixed waste streams. ~~The TWBIR~~ *CRA-2004* has adopted this system to remain consistent with common terminology used by the DOE *TRU* waste ~~generator and storage~~ sites. WMCs are verified with radiographic examination (using either real-time radiography [RTR] or an equivalent methodology) and/or visual examination.

Waste Stream Profile – This is a description of a CH-TRU or RH-TRU waste stream. ~~Examples of information included in a w~~ *W*aste stream profile*s include* ~~are~~

- waste stream description*;*

- waste stream source description, *waste stream identification codes, final waste form;*

- ~~currently used identification codes, including the DOE TRU waste site matrix description;~~

- ~~final waste form assigned by the TRU waste generator and storage sites;~~

- as-generated waste form volumes and final waste form volumes,

- estimated ~~minimum,~~ average *values for WMP densities;* ~~, and maximum weights of waste components per cubic meter of final waste form volume (for example, iron-base metal and alloys, aluminum-base metal and alloys, cellulosics, etc.);~~

- identification of whether the waste is CH-TRU or RH-TRU;

- final waste form radionuclide inventory (activity in ~~curies~~ *Ci* per cubic meter); and

- comments provided by the TRU waste ~~generator and storage~~ sites to further explain the data provided.

~~Site-Specific Waste Profile – This represents a final waste form at a particular DOE TRU waste generator and storage site. That is, one or more waste stream profiles at a particular DOE TRU waste site that have been placed in the same final waste form are summarized in the site-specific waste profile. Examples of information included in a site-specific waste profile are~~

1   • ~~DOE TRU waste generator and storage site identification;~~

2   • ~~final waste form that the profile represents;~~

3   • ~~listing of the waste streams (represented by waste stream profiles provided by the TRU~~
4   ~~waste generator and storage sites) that are included in the site-specific waste profile,~~
5   ~~including the waste stream identification;~~

6   • ~~final waste form volumes (both stored and currently projected); and~~

7   • ~~summary of minimum, average, and maximum weights of WMPs per cubic meter of final~~
8   ~~waste form volume on a site basic (for example, iron-base metal and alloys, aluminum-~~
9   ~~base metal and alloys, cellulosies, etc.).~~

10 WIPP Waste Profile – The WIPP waste profile represents a summary of TRU wastes at all ~~DOE~~
11 TRU waste ~~generator and storage~~ sites that have an identical final waste form. ~~Examples of~~
12 ~~information included in a~~ WIPP waste profile*s include*: ~~are~~

13   • the final waste form that the profile represents;

14   • *a* listing of the ~~DOE~~ TRU waste sites (represented by the same final waste form) that are
15   included in the WIPP waste profile~~,~~*;* ~~including the name of the DOE TRU waste site;~~

16   • final waste form volumes of stored and ~~currently~~ projected waste for each ***TRU waste***
17   site*;* and

18   • *a* summary of ***the WMP*** ~~minimum, volume-weighted~~ average ***densities***~~, and maximum~~
19   ~~weights of WMPs per cubic meter of final waste form volume on a WIPP basis (for~~
20   ~~example, iron-base metal and alloys, aluminum-base metal and alloys, cellulosies~~, etc.).

21 ***Waste Material Parameters (***WMP***)*** – This is one or more of the ~~nonradioactive~~ TRU waste
22 stream constituents. The 12 WMPs have been grouped by their chemical and physical properties
23 as shown in the following list.

24 <u>Inorganics</u>

25   • Iron-based metals and alloys — includes iron and steel alloys in the waste and does not
26   include the waste container materials.

27   • Aluminum-based metals and alloys.

28   • Other metal and alloys — includes all other metals found in the waste materials (for
29   example, copper, lead, zirconium, tantalum, etc.). The lead portion of lead rubber gloves
30   and aprons is also included in this category.

31   • Other inorganic materials — includes inorganic nonmetal waste materials such as
32   concrete, glass, firebrick, ceramics, sand, and inorganic sorbents.

- Vitrified materials — includes waste that has been melted or fused at high temperatures with glass-forming additives such as soil or silica to form a homogeneous glass-like matrix.

Organics

- Cellulosic *Material*s — includes those materials generally derived from high-polymer plant carbohydrates. Examples are paper, cardboard, kimwipes, wood, cellophane, cloth, etc.

- Rubber — includes natural or synthetic elastic latex materials. Examples are Hypalon, neoprene, surgical gloves, leaded-rubber gloves (rubber part only), etc.~~)~~

- Plastics — includes generally synthetic materials, often derived from petroleum feedstock. Examples are polyethylene, polyvinylchloride, Lucite, Teflon, etc.~~.~~

Solidified Materials

- Inorganic matrix — includes any homogenous materials consisting of sludge or aqueous-based liquids that are solidified with cement, Envirostone, or other solidification agents. Examples are wastewater treatment sludge, cemented aqueous liquids, inorganic particulates, etc.~~)~~

- Organic matrix — includes cemented organic resins, solidified organic liquids, and sludges.

- Cement — includes the cement used in solidifying liquids, particulates, and sludges.

Soils

- Soils — generally consists of naturally occurring soils that have been contaminated with inorganic radioactive waste materials.

Although not considered to be a waste component, the associated packaging materials are also listed because they also provide input to the ~~performance assessment~~ *PA* calculations.

Packaging Materials

- Steel — weight of the steel component of the standard container. Any necessary overpacking is included in the weight of steel.

- Plastics — weight of any standard plastic secondary confinement within the container.

- Lead — weight of the lead shielding.

The estimated WMP information is expressed in units of kilograms per cubic meter ~~of waste matrix~~ *corresponding to the volume the waste package will occupy in the repository*. This unit

1 facilitates scaling the material parameters to address various volumes for ~~performance~~
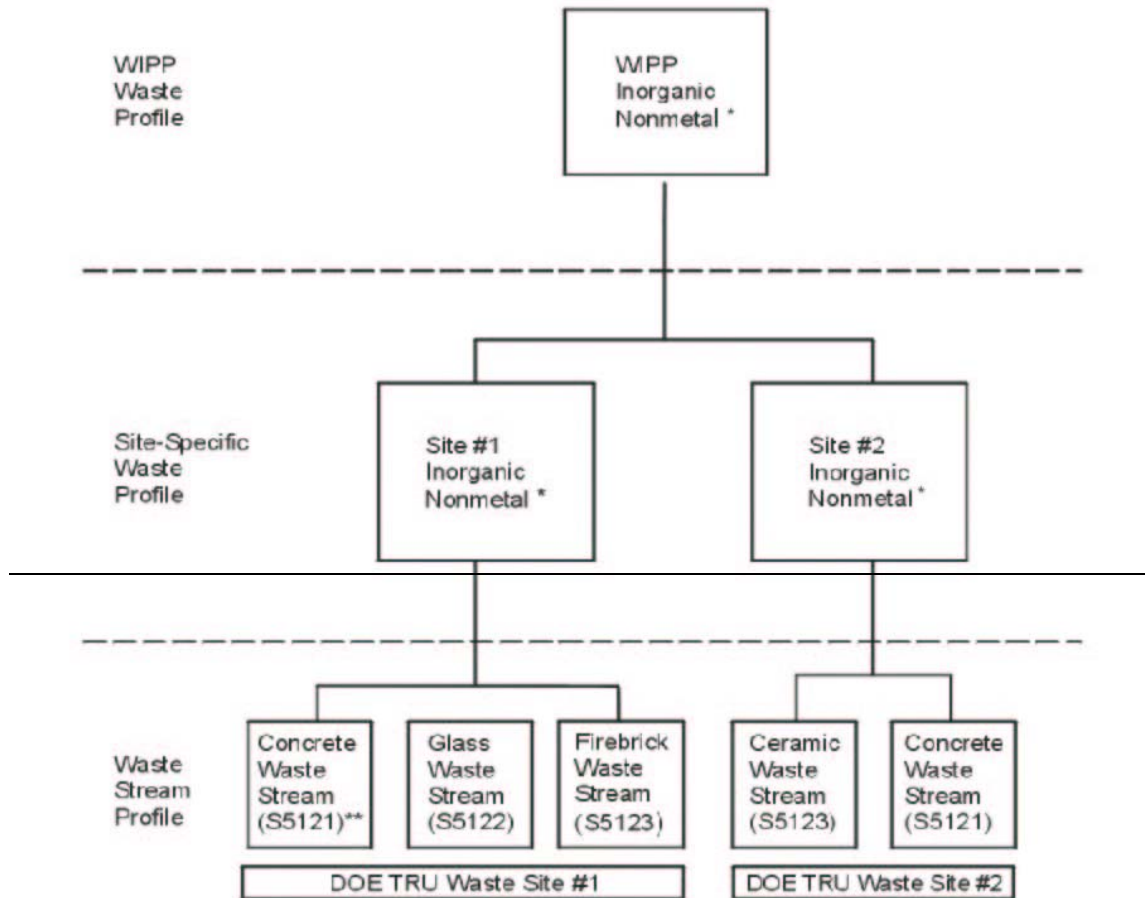2 ~~assessment~~ *PA* calculations and sensitivity analysis.

3 4.1.3.2   Nonradionuclide Inventory Roll-*U*p

4 The DOE uses the eleven final waste forms ~~in the TWBIR~~ as an intermediate step in determining
5 the inventory of ~~nonradioactive~~ *nonradionuclide* waste components. These final waste forms
6 are a convenient way for the DOE to categorize waste for the purpose of waste management and
7 waste characterization prior to shipment to the WIPP. Waste streams at each TRU waste
8 ~~generator and storage~~ site with similar WMCs are grouped together into one of the 11 final waste
9 forms. ~~as shown in Table 4-2.~~ ~~An example of the methodology for grouping waste stream~~
10 ~~information is illustrated in Figure 4-3.~~ The grouping of individual waste stream profiles into a
11 ~~site-specific~~ *WIPP* waste profile is based on the similar physical and chemical properties of the
12 waste streams. ~~In the example in Figure 4-3, because of their similar properties for performance~~
13 ~~assessment modeling, concrete waste, glass waste, firebrick waste, and ceramic waste mainly~~
14 ~~influence the estimation of porosity and permeability in the waste panel region (see Figure 6-13)~~
15 ~~of the model. Therefore, the three streams within the DOE TRU Waste Site #1 and the two at~~
16 ~~DOE TRU Waste Site #2 can be grouped together at each site based on similar physical and~~
17 ~~chemical properties and placed into the site-specific waste profile inorganic nonmetal waste,~~
18 ~~with the final waste form defined in Table 4-2.~~

19 *Current estimates of the final waste form volumes for CH-TRU and RH-TRU waste are*
20 *provided in Table 4-4. For comparison, estimates* ~~Estimates~~ of the ~~WIPP~~ final waste-form
21 volumes for CH-TRU and RH-TRU waste *from the CCA are also provided in Table 4-4* ~~4-3~~.
22 *The relative contribution of heterogeneous debris, solidified organics, and filters to the*
23 *current reported CH-TRU waste volume has increased when compared to the CCA inventory*
24 *estimate. The most notable increase is in the heterogeneous debris category. SRS, LANL,*
25 *RFETS, and INEEL all reported larger expected volumes of heterogeneous debris in the*
26 *CRA-2004 data call than they reported for the CCA inventory estimate. Larger volumes of*
27 *heterogeneous debris are expected to come from the FB (F-Canyon at SRS) and HB (H-*
28 *Canyon at SRS) process lines, facility and equipment operations at LANL, decontamination*
29 *and decommissioning at RFETS, and the start-up of the Advanced Mixed Waste Treatment*
30 *Facility (AMWTF) at INEEL.*

31 *The relative contribution of uncategorized metal, graphite, soil and combustibles to the*
32 *current reported CH-TRU waste volume has decreased when compared to the CCA inventory*
33 *estimate. The most notable decrease is in the uncategorized metal category. Hanford-RL,*
34 *LANL, and INEEL all reported smaller expected volumes of uncategorized metal in the CRA-*
35 *2004 data call than in the CCA inventory estimate due primarily to reassignment of the waste*
36 *to other forms based on new characterization information.*

37 *The relative contribution of inorganic non-metal, filters, soils, solidified organics, and*
38 *solidified inorganics to the current reported RH-TRU waste volume has increased when*
39 *compared to the CCA estimate. The most notable increase is in the solidified inorganic*
40 *category. Hanford-RP and Hanford-RL reported larger expected volumes of solidified*
41 *inorganics in the CRA-2004 data call than in the CCA inventory estimate. Larger*

WIPP Waste Profile — WIPP Inorganic Nonmetal *

Site-Specific Waste Profile — Site #1 Inorganic Nonmetal * — Site #2 Inorganic Nonmetal *

Waste Stream Profile — Concrete Waste Stream (S5121)** — Glass Waste Stream (S5122) — Firebrick Waste Stream (S5123) — Ceramic Waste Stream (S5123) — Concrete Waste Stream (S5121)

DOE TRU Waste Site #1   DOE TRU Waste Site #2

* See Table 4-2 for WMCs that can occur in each final waste form
** WMC

Note: Adapted from Figure 1-2, TWBIR, Revision 3.

CCA-079-2

Figure 4-3. Schematic of Waste Stream Profile Methodology

volumes of solidified inorganics are expected from Hanford-RP due to the waste in underground storage tanks.

The relative contribution of uncategorized metal to the currently reported RH-TRU volume has decreased when compared to the CCA estimate. Hanford-RL reassigned a significant volume of waste that was reported as uncategorized metal in the CCA to other forms based on new characterization information.

To establish the nonradioactive waste component inventory, ~~the~~ DOE accumulated WMP information *(as WMP average densities in units of kg/m^3)* in the ~~TWBIR~~ *CRA-2004 data call* by final waste form. This accumulation is shown as a series of tables (Tables ~~3-1~~ *DATA-F-10* through ~~3-18~~ *DATA-F-30* in Appendix ~~BIR~~ *DATA, Attachment F*). ~~in the TWBIR.~~

1   **Table 4-3. Anticipated Nonradionuclide TRU Waste Inventory for the WIPP**

Final Waste Forms	Stored Volumes (cubic meters)	Projected Volumes (cubic meters)	Anticipated Volumes (cubic meters)	WIPP Disposal Volumes (cubic meters)
CH Waste				
Combustible	5.8E+03	4.6E+03	1.0E+04	1.4E+04
Filter	2.2E+02	5.1E+02	7.3E+02	1.2E+03
Graphite	5.1E+02	4.8E+01	5.6E+02	6.0E+02
Heterogeneous	2.7E+04	1.3E+04	4.0E+04	5.1E+04
Inorganic Nonmetal	3.1E+03	9.4E+02	4.1E+03	4.9E+03
Lead and Cadmium Metal Waste	3.5E+01	3.3E+02	3.7E+02	6.6E+02
Salt Waste	2.1E+01	3.3E+02	3.5E+02	6.4E+02
Soils	4.1E+02	6.0E+03	6.4E+03	1.2E+04
Solidified Inorganics	9.6E+03	4.5E+03	1.4E+04	1.8E+04
Solidified Organics	9.1E+02	7.5E+01	9.8E+02	1.1E+03
Uncategorized Metal	1.1E+04	2.3E+04	3.4E+04	5.4E+04
Total CH Volumes	5.8E+04	5.4E+04	1.1E+05	1.6E+05
RH Waste				
Combustible	3.6E+01	4.9E+01	8.5E+01	
Heterogeneous	2.3E+03	5.5E+03	7.8E+03	
Inorganic Non-Metal	4.6E+01	2.1E+01	6.8E+01	
Lead and Cadmium Metal Waste	7.1E+00	6.7E+01	7.4E+01	
Solidified Inorganics	1.1E+03	2.3E+02	1.3E+03	
Solidified Organics	3.6E+00	0.0E+00	3.6E+00	
Uncategorized Metal	1.2E+02	1.7E+04	1.8E+04	
Total RH Volumes	3.6E+03	2.3E+04	2.7E+04	7.1E+03[1]
Total TRU Waste Volumes	6.2E+04	7.7E+04	1.4E+05	1.7E+05

Source: Adapted from TWBIR, Revision 3, Table 2-1
[1] WIPP is limited to 7,079 cubic meters of RH-TRU waste.

2   These ***average densities*** are further summed to determine the total WIPP waste component
3   disposal inventory for CH-TRU and RH-TRU waste and are given in ***Tables DATA-F-31 and***
4   ***DATA-F-32 of Appendix DATA, Attachment F, and are reproduced here with a comparison to***
5   ***the CCA inventory values in*** Tables 4-5~~4~~ ***(CH-TRU waste)*** and 4-6~~5~~ ***(RH-TRU waste)***,
6   respectively. It should be noted that MgO is not listed in these tables. Since MgO is not a
7   component of the waste, it is not regarded as a WMP. A discussion of the MgO ~~backfill~~ is
8   contained in Chapter 3.0***; CCA*** Appendix BACK ***and CCA*** Appendix SOTERM***; Appendix***
9   ***BARRIERS; and Appendix PA, Attachment SOTERM.***

Table 4-4. Nonradionuclide TRU Waste Inventory for the WIPP

Final Waste Forms	Current Inventory Volumes (m^3)				Volumes Reported in the CCA (m^3) [1]			
	Emplaced	Stored	Projected	WIPP Disposal	Emplaced	Stored	Projected	WIPP Disposal
	CH-TRU Waste				CH-TRU Waste			
Combustible	6.1×10^2	4.3×10^3	1.9×10^3	8.9×10^3	--	5.8×10^3	4.6×10^3	1.4×10^4
Filter	3.4×10^2	9.9×10^2	5.9×10^2	2.6×10^3	--	2.2×10^2	5.1×10^2	1.2×10^3
Graphite	0.0×10^0	1.2×10^2	1.3×10^0	1.2×10^2	--	5.1×10^2	4.8×10^1	6.0×10^2
Heterogeneous	5.7×10^2	4.9×10^4	9.7×10^3	7.0×10^4	--	2.7×10^4	1.3×10^4	5.1×10^4
Inorganic Nonmetal	9.7×10^2	1.1×10^4	6.8×10^1	1.2×10^4	--	3.1×10^3	9.4×10^2	4.9×10^3
Lead and Cadmium Metal Waste	8.1×10^1	1.4×10^2	3.2×10^1	2.9×10^2	--	3.5×10^1	3.3×10^2	6.6×10^2
Salt Waste	1.5×10^3	1.5×10^2	1.9×10^2	2.1×10^3	--	2.1×10^1	3.3×10^2	6.4×10^2
Soils	0.0×10^0	3.0×10^2	6.0×10^3	1.3×10^4	--	4.1×10^2	6.0×10^3	1.2×10^4
Solidified Inorganics	3.3×10^3	3.5×10^4	7.3×10^2	4.0×10^4	--	9.6×10^3	4.5×10^3	1.8×10^4
Solidified Organics	0.0×10^0	5.2×10^3	3.8×10^2	6.0×10^3	--	9.1×10^2	7.5×10^1	1.1×10^3
Uncategorized Metal	3.6×10^2	2.4×10^3	5.1×10^3	1.4×10^4	--	1.1×10^4	2.3×10^4	5.4×10^4
Total CH-TRU Waste Volumes	7.7×10^3	1.1×10^5	2.5×10^4	1.7×10^5	--	5.8×10^4	5.4×10^4	1.6×10^5

Source: Current inventory volumes - Appendix DATA, Attachment F; Volume reported in the CCA – TWBIR Revision 3

[1] Comparisons between the current inventory values and the values reported in the CCA are made in detail in Appendix DATA, Attachment F, Annex B

[2] The WIPP is limited to 7,079 m^3 of RH-TRU waste by agreement with the State of New Mexico.

Table 4-4. Nonradionuclide TRU Waste Inventory for the WIPP — Continued

Final Waste Forms	Current Inventory Volumes (m^3)				Volumes Reported in the CCA (m^3) [1]			
	Emplaced	Stored	Projected	WIPP Disposal	Emplaced	Stored	Projected	WIPP Disposal
	RH-TRU Waste				RH-TRU Waste			
Combustible	--	1.8×10^1	8.9×10^{-1}	1.8×10^1	--	3.6×10^1	4.9×10^1	--
Filter	--	8.9×10^0	8.9×10^0	1.0×10^1	--	--	--	--
Heterogeneous	--	6.1×10^2	3.8×10^3	1.3×10^3	--	2.3×10^3	5.5×10^3	--
Inorganic Non-Metal	--	4.3×10^1	4.4×10^1	5.1×10^1	--	4.6×10^1	2.1×10^1	--
Lead and Cadmium Metal Waste	--	1.2×10^1	7.1×10^0	1.3×10^1	--	7.1×10^0	6.7×10^1	--
Soils	--	0.0×10^0	2.0×10^2	3.4×10^{-1}	--	--	--	--
Solidified Inorganics	--	4.5×10^3	3.3×10^2	4.6×10^3	--	1.1×10^3	2.3×10^2	--
Solidified Organics	--	9.5×10^0	0.0×10^0	9.5×10^0	--	3.6×10^0	0.0×10^0	--
Uncategorized Metal	--	8.4×10^1	6.1×10^3	1.1×10^3	--	1.2×10^2	1.7×10^4	--
Total RH-TRU Waste Volumes [2]	--	5.3×10^3	1.0×10^4	7.1×10^3	--	3.6×10^3	2.3×10^4	– –
Total TRU Waste Volumes	7.7×10^3	1.1×10^5	3.5×10^4	1.8×10^5	-	6.2×10^4	7.7×10^4	1.7×10^5

Source: Current inventory volumes - Appendix DATA, Attachment F; Volume reported in the CCA – TWBIR Revision 3
[1] Comparisons between the current inventory values and the values reported in the CCA are made in detail in Appendix DATA; Attachment F, Annex B
[2] The WIPP is limited to 7,079 m^3 of RH-TRU waste by agreement with the State of New Mexico.

1   ~~The~~ DOE reports the average density for WMPs because these values are used to generate the
2   waste-related inputs for ~~performance assessment~~ *PA*. Section 3.4 of the TWBIR recommends
3   use of the average value, based on the methodology used to obtain and report data. ~~Section 3.3~~
4   ~~of the TWBIR provides a formula for determining the average WMP densities.~~ *CRA-2004 also*
5   *uses average values for the WMPs to generate waste-related inputs for PA.*

6   *Analysis of the current inventory estimate and the CCA inventory estimate for CH-TRU waste*
7   *shows that waste materials expected for shipment to WIPP have changed slightly since the*
8   *CCA. The relative occurrence (expressed as the kg/m^3 of a given material in the waste) of iron*
9   *(Fe), aluminum (Al), and other metal alloys is smaller in the current inventory estimate than it*
10 *was in the CCA inventory estimate. In addition, the relative occurrence of solidified organics,*
11 *cement, soils, and vitrified material is smaller in the current inventory estimate than it was in*
12 *the CCA inventory estimate. In contrast, the relative occurrence of cellulosic, plastic, and*
13 *rubber (CPR) materials and other inorganic materials is larger in the current inventory*
14 *estimate than it was in the CCA inventory estimate. The current inventory estimate reflects a*
15 *shift from an expected waste form consisting of 40 percent metals, 15 percent CPR materials*
16 *and 45 percent other materials reported in the CCA to a waste form that consists of 34 percent*
17 *metals, 25 percent CPR materials and 41 percent other materials. The current inventory*
18 *estimate reflects a higher occurrence of CPR materials primarily because of a process change*
19 *at INEEL. At the time of the CCA, INEEL expected to thermally treat a significant quantity*
20 *of waste that contained higher than average quantities of CPR materials. Through the*
21 *process of thermal treatment, the CPR materials in the waste would be destroyed. INEEL*
22 *currently plans to supercompact the waste that they had originally planned to thermally treat.*
23 *Supercompaction does not destroy CPR materials in the waste. As a consequence, the waste*
24 *expected to come to WIPP from INEEL has increased CPR materials relative to those reported*
25 *for the CCA.*

26   **~~Table 4-4. WIPP CH-TRU WMP Disposal Inventory~~**

~~Waste Components~~	~~Average (kilograms per cubic meter)~~
~~Iron Base Metal and Alloys~~	~~170~~
~~Aluminum Base Metal and Alloys~~	~~18~~
~~Other Metal and Alloys~~	~~67~~
~~Other Inorganic Materials~~	~~31~~
~~Vitrified~~	~~55~~
~~Cellulosics~~	~~54~~
~~Rubber~~	~~10~~
~~Plastics~~	~~34~~
~~Solidified Inorganic Material~~	~~54~~
~~Solidified Organic Material~~	~~5.6~~
~~Cement (Solidified)~~	~~50~~
~~Soils~~	~~44~~
~~Container Materials - kilograms per cubic meter~~	
~~Steel~~	~~139~~
~~Plastic and Liners~~	~~26~~
~~*Source*: Adapted from TWBIR, Revision 3, Table 2-2.~~	

1   *Table 4-5. WIPP CH-TRU Waste and Container Material Disposal Inventory*

Waste Materials	Average Density Based on Current Inventory (kg/m^3)	Average Density Reported in the CCA (kg/m^3)
Waste Materials		
Fe-Base Metal/Alloys	1.1×10^2	1.7×10^2
Al-Base Metal/Alloys	1.4×10^1	1.8×10^1
Other Metal/Alloys	3.0×10^1	6.7×10^1
Other Inorganic Materials	4.2×10^1	3.1×10^1
Vitrified Materials	6.2×10^0	5.5×10^1
Cellulosic Material	5.8×10^1	5.4×10^1
Rubber	1.4×10^1	1.0×10^1
Plastic	4.2×10^1	3.4×10^1
Solidified Inorganic Materials	7.7×10^1	5.4×10^1
Solidified Organic Materials	1.6×10^1	5.6×10^0
Cement (Solidified)	2.9×10^1	5.0×10^1
Soil	1.9×10^1	4.4×10^1
Container Materials		
Steel	1.7×10^2	1.4×10^2
Plastic and Liners	1.6×10^1	2.6×10^1
Lead	1.4×10^{-2}	0.0×10^0

Source: Appendix DATA, Attachment F.

2   ~~**Table 4-5. WIPP RH-TRU WMP Disposal Inventory**~~

~~Waste Components~~	~~Average (kilograms per cubic meter)~~
~~Iron Base Metal and Alloys~~	~~10~~
~~Aluminum Base Metal and Alloys~~	~~7.1~~
~~Other Metal and Alloys~~	~~250~~
~~Other Inorganic Materials~~	~~64~~
~~Vitrified~~	~~4.7~~
~~Cellulosics~~	~~17~~
~~Rubber~~	~~3.3~~
~~Plastics~~	~~15~~
~~Solidified Inorganic Material~~	~~22~~
~~Solidified Organic Material~~	~~.093~~
~~Cement (Solidified)~~	~~19~~
~~Soils~~	~~1~~
~~Container Materials - kilograms per cubic meter~~	
~~Steel~~	~~446~~
~~Plastic and Liners~~	~~3.1~~
~~Lead~~	~~465~~
~~Steel Plug~~	~~2145~~

~~*Source*: Adapted from TWBIR, Revision 3, Table 2-2.~~

1 *Table 4-6. WIPP RH-TRU Waste and Container Material Disposal Inventory*

Waste Materials	Average Density Based on Current Inventory (kg/m^3)	Average Density Reported in the CCA (kg/m^3)
Waste Materials		
Fe-Base Metal/Alloys	1.1×10^2	1.0×10^1
Al-Base Metal/Alloys	2.5×10^0	7.1×10^0
Other Metal/Alloys	3.2×10^1	2.5×10^2
Other Inorganic Materials	3.5×10^1	6.4×10^1
Vitrified Materials	5.7×10^{-2}	4.7×10^0
Cellulosic Material	4.5×10^0	1.7×10^1
Rubber	3.1×10^0	3.3×10^0
Plastic	4.9×10^0	1.5×10^1
Solidified Inorganic Materials	3.9×10^1	2.2×10^1
Solidified Organic Materials	4.0×10^0	9.3×10^{-1}
Cement (Solidified)	8.7×10^{-1}	1.0×10^0
Soil	2.6×10^1	
Container Materials		
Steel	4.8×10^2	4.5×10^2
Plastic and Liners	1.4×10^0	3.1×10^0
Lead	4.4×10^2	4.7×10^2

Source: Appendix DATA, Attachment F

3 *The container materials for CH-TRU waste are primarily steel, plastic, and lead. The current*
4 *inventory estimate reflects a higher occurrence of steel, a lower occurrence of plastic, and a*
5 *higher occurrence of lead in the packages coming to WIPP when compared to the CCA*
6 *inventory estimate. Additional steel in packages currently planned to come to WIPP results*
7 *from the planned increased use of overpacks (Type A or equivalent packages, pipe overpacks,*
8 *ten-drum overpacks, 100-gallon drum overpacks, etc.). The increased use of overpack*
9 *containers in the current inventory estimate also leads to a reduction in the use of plastic*
10 *liners in packages coming to WIPP. Thus, the density of plastic packaging material is smaller*
11 *than it was in the CCA inventory estimate.*

12 ~~With regard to t~~*T*he inventory of chemical components of the waste (needed for scoping
13 calculations to determine their importance on performance)~~, this information~~ was requested *in*
14 *the CRA-2004 data call* ~~from the generator/storage sites by the DOE subsequent to the issuance~~
15 ~~of Revision 2 of the TWBIR~~. The information requested by ~~the~~ DOE was specific to solidified
16 waste forms destined for disposal at the WIPP and included complexing agents, nitrates, sulfates,
17 phosphates, and cement. ~~A summary of this supplemental information can be found in Sections~~
18 ~~3.3.1, 3.3.2, and 3.3.3 of the TWBIR, Revision 3~~. *A summary of this information can be found*
19 *in Appendix DATA, Attachment F.* Additional information addressing the impact, limits, and
20 characterization (or noncharacterization) of these chemical components is provided in Appendix
21 *TRU WASTE, Sections TRU WASTE-2.0 and TRU WASTE-3.0.* ~~WCA~~, ~~Appendix WCL,~~
22 ~~Section 4.4, and Tables 4-1 and 4-13~~. The importance of these chemical components to

1 performance assessment *PA* is assessed in Appendix *TRU WASTE, Section TRU WASTE-*
2 *2.0*WCA.

3 4.1.3.3   Radionuclide Inventory Roll-*U*p

4 Estimates of the radionuclide inventory are included in the TWBIR *Appendix DATA,*
5 *Attachment F.* Generators *TRU waste sites* derive these estimates based on acceptable
6 knowledge including any quantitative results that may be available. *In the data call for CRA-*
7 *2004, TRU waste sites reported estimated values for radionuclide activities on a waste stream*
8 *basis including both the stored and projected components.* The *actual activity* radioactive
9 inventory of disposed waste will be *is* determined quantitatively prior to shipment*,* as discussed
10 in Section 4.2.2 *4.4.2*.

11 The estimates of radioactivity provided by the generator and storage sites are for stored waste
12 only. Assuming the radionuclide distribution for projected waste to be the same as the stored
13 waste inventory.

14 *The disposal radionuclide inventory for PA is a calculated value based on the radionuclide*
15 *activities reported for emplaced, stored, and projected waste. The radionuclide activities in the*
16 *projected component of the waste are scaled using the scaling factor and added to the*
17 *radionuclide activities for stored and emplaced components of the waste.*

18 For the CCA, it is possible to scale the activity of the stored radionuclide inventory to the full
19 WIPP repository. This assumption is reasonable because no new waste forms or waste
20 generating processes are anticipated for the future and radionuclide distributions for the DOE
21 weapons program activities are well known. The WIPP disposal radionuclide inventory has been
22 estimated on the basis of these assumptions by first calculating the activity per unit volume (that
23 is, curies per cubic meter) of each radionuclide that is present in the stored waste at each site.
24 This calculation is based on all radionuclide activities decayed to the end of 1995 *2001*.
25 Radioactive decay and build-up calculations were are performed annually and reported in the
26 TWBIR using the commercially available code ORIGEN2 (Croff 1980). The levels of
27 radioactivity reported include contributions from both parent and daughter decay products. The
28 curies per cubic meter calculated for each radionuclide in the stored waste at each site are then
29 multiplied by the volume of projected waste to estimate the total curies of each radionuclide in
30 the projected waste. The curies for the stored and the projected waste for each individual
31 radionuclide at all sites are then added to obtain the total curies for CH-TRU and RH-TRU
32 waste. For CH-TRU waste, the total curies *Ci* for each radionuclide is divided by the CH-TRU
33 disposal inventory *volume* to obtain a curies *Ci* per cubic meter concentration for each
34 radionuclide on a repository level. For RH-TRU waste, the total decayed WIPP curies *Ci* for
35 each radionuclide is divided by the sum of the stored and actual projected RH-TRU waste
36 *disposal* volume to obtain a radionuclide concentration in curies *Ci* per cubic meter.

37 The WIPP disposal radionuclide inventory to be used in this application *PA* for both CH-TRU
38 and RH-TRU wastes is shown in Table 4-7*6*. *Activities at closure (2033) are used in PA.* The
39 table shows individual radionuclide activity in curies *Ci* for both CH-TRU and RH-TRU waste.
40 Based on the total curies *Ci* shown in Table 4-7*6* and to the extent to which each radionuclide is
41 regulated by 40 CFR § *Section* 191.13, approximately 99.9 *98.6* percent of the regulated CH-
42 TRU activity at repository closure is contributed by ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am.

1 **Table 4-6. Important Radionuclides Considered in Performance Assessment**

Radionuclide	Inventory at Closure (Curies)	EPA Units at Closure	EPA Units at 10,000 years	Release Calculations (1)		
				Cuttings, Cavings, & Spall Release	Direct Brine Release	Culebra Release
Pu-238	1.94E+06	5.63E+03	1.32E-22	*	*	(2)
Pu-239	7.95E+05	2.31E+03	1.73E+03	*	*	*
Am-241	4.88E+05	1.42E+03	1.55E-01	*	*	*
Pu-240	2.14E+05	6.23E+02	2.16E+02	*	*	e
Cs-137	9.31E+04	2.71E+01	0.00E+00	*	—	—
Sr-90	8.73E+04	2.54E+01	0.00E+00	*	—	—
U-233	1.95E+03	5.67E+00	5.44E+00	*	*	e
U-234	7.51E+02	2.18E+00	4.09E+00	*	*	*
Th-230	3.06E-01	8.88E-03	3.56E+00	—	*	*
Pu-242	1.17E+03	3.40E+00	3.34E+00	—	*	e
Th-229	9.97E+00	2.90E-02	3.40E+00	—	*	e
Np-237	6.49E+01	1.89E-01	4.82E-01	—	*	—
Cm-245	1.15E+02	3.33E-01	1.48E-01	—	*	—
Ra-226	1.14E+01	3.32E-02	2.77E-01	—	—	—
Pb-210	8.75E+00	2.54E-02	2.77E-01	—	*	—
U-238	5.01E+01	1.46E-01	1.46E-01	—	*	—
U-236	6.72E-01	1.95E-03	1.16E-01	—	*	—
Am-243	3.25E+01	9.45E-02	3.69E-02	—	*	—
U-235	1.75E+01	5.08E-02	7.06E-02	—	*	—
Cm-243	2.07E+01	6.03E-02	0.00E+00	—	*	—
U-232	1.79E+01	5.21E-02	0.00E+00	—	—	—
C-14	1.28E+01	3.72E-02	1.11E-02	—	—	—
Th-232	1.01E+00	2.92E-02	2.92E-02	—	*	—
Ac-227	5.05E-01	1.47E-03	1.28E-02	—	—	—
Pa-231	4.67E-01	1.36E-03	1.28E-02	—	—	—
Cm-248	3.72E-02	1.08E-04	1.06E-04	—	*	—
Pu-244	1.51E-06	4.40E-09	1.26E-08	—	*	—
Pu-241	3.94E+05	(3)	(3)	*	*	—
Cm-244	7.44E+03	(3)	(3)	*	*	—
Percent of EPA Units at closure included in calculation				99.96%	99.48%	43.45%
Percent of EPA Units at 10,000 years included in calculation				99.40%	99.98%	99.92%

2 (1) See Section 6.3 for a discussion of scenarios analyzed by performance assessment and the release pathways.
3 (2) Pu-238 was included in the Salado transport calculations but the release to the Culebra was too low to merit calculation of its transport within
4 the Culebra. The EPA unit percent total at closure increases to 99.47% with Pu-238 added; the percent at 10,000 years is unaffected.
5 (3) Pu-241 and Cm-244 are not regulated by 40 CFR Part 191 but are included because their daughters, Am241 and Pu240 respectively, are
6 significant to performance
7 x indicates an isotope included in calculation
8 e indicates isotopes that are combined for transport with isotopes having similar characteristics.

Table 4-7. Radionuclides Considered in PA

Radionuclide	Current Inventory Values			Values Reported in the CCA			Release Calculations (1)			
	Inventory at Closure (Ci)	EPA Units		Inventory at Closure (Ci)	EPA Units		Cuttings, Cavings, and Spall Release	Direct Brine Release	Salado Release	Culebra Release
		At Closure[4]	At 10,000 years		At Closure	At 10,000 years				
^{238}Pu	1.25×10^6	5.04×10^3	2.61×10^{-23}	1.94×10^6	5.64×10^3	1.32×10^{-22}	x	x	(2)	(2)
^{239}Pu	6.65×10^5	2.68×10^3	2.01×10^3	7.95×10^5	2.31×10^3	1.73×10^3	x	x	x	x
^{241}Am	4.58×10^5	1.84×10^3	2.48×10^{-4}	4.88×10^5	1.42×10^3	1.78×10^{-4}	x	x	x	x
^{240}Pu	1.08×10^5	4.36×10^2	1.51×10^2	2.14×10^5	6.22×10^2	2.16×10^2	x	x	c	c
^{137}Cs	1.79×10^5	7.19×10^1	0.00×10^0	9.31×10^4	2.71×10^1	0.00×10^0	x	--	--	--
^{90}Sr	1.42×10^5	5.71×10^1	0.00×10^0	8.73×10^4	2.54×10^1	0.00×10^0	x	--	--	--
^{233}U	1.27×10^3	5.12×10^0	4.91×10^0	1.95×10^3	5.67×10^0	5.44×10^0	x	x	c	c
^{229}Th	5.39×10^0	2.17×10^{-2}	3.04×10^0	9.97×10^0	2.90×10^{-2}	3.40×10^0	--	x	c	c
^{234}U	3.19×10^2	1.28×10^0	3.03×10^0	7.51×10^2	2.18×10^0	4.10×10^0	x	x	x	x
^{230}Th	1.76×10^{-1}	7.07×10^3	2.64×10^0	3.06×10^{-1}	8.90×10^3	3.55×10^0	--	x	x	x
^{238}U	1.54×10^2	6.21×10^{-1}	6.21×10^{-1}	5.01×10^1	1.46×10^{-1}	1.46×10^{-1}	--	x	--	--
^{237}Np	1.01×10^1	4.06×10^{-2}	4.27×10^{-1}	6.49×10^1	1.89×10^{-1}	4.83×10^{-1}	--	x	--	--
^{232}Th	6.83×10^0	2.75×10^{-1}	2.75×10^{-1}	1.01×10^0	2.94×10^{-2}	2.94×10^{-2}	--	x	--	--
^{226}Ra	6.28×10^0	2.53×10^{-2}	2.07×10^{-1}	1.14×10^1	3.31×10^{-2}	2.77×10^{-1}	--	--	--	--
^{210}Pb	4.94×10^0	1.99×10^{-2}	2.07×10^{-1}	8.75×10^0	2.54×10^{-2}	2.77×10^{-1}	--	x	--	--
^{242}Pu	2.71×10^1	1.09×10^{-1}	1.07×10^{-1}	1.17×10^3	3.40×10^0	3.34×10^0	--	x	c	c
^{243}Am	2.17×10^1	8.75×10^{-2}	5.74×10^{-2}	3.25×10^1	9.45×10^{-2}	3.69×10^{-2}	--	x	--	--
^{236}U	1.65×10^0	6.66×10^{-3}	8.62×10^{-2}	6.72×10^{-1}	1.95×10^{-3}	1.16×10^{-1}	--	x	--	--
^{235}U	2.28×10^0	9.18×10^{-3}	3.21×10^{-2}	1.75×10^1	5.09×10^{-2}	7.06×10^{-2}	--	x	--	--
^{14}C	3.25×10^0	1.31×10^{-2}	3.90×10^{-3}	1.28×10^1	3.72×10^{-2}	1.11×10^{-2}	--	--	--	--
^{232}U	3.06×10^0	1.23×10^{-2}	0.00×10^0	1.79×10^1	5.20×10^{-2}	0.00×10^0	--	--	--	--
^{227}Ac	9.57×10^{-1}	3.85×10^{-3}	8.06×10^{-3}	5.05×10^{-1}	1.47×10^{-3}	1.28×10^{-2}	--	--	--	--
^{231}Pa	1.21×10^0	4.88×10^{-3}	8.06×10^{-3}	4.67×10^{-1}	1.36×10^{-3}	1.28×10^{-2}	--	--	--	--
^{243}Cm	4.07×10^{-1}	1.64×10^{-3}	0.00×10^0	2.07×10^1	6.02×10^{-2}	0.00×10^0	--	x	--	--
^{248}Cm	9.32×10^{-2}	3.75×10^{-4}	3.68×10^{-4}	3.72×10^{-2}	1.08×10^{-4}	1.06×10^{-4}	--	x	--	--
^{245}Cm	1.92×10^{-2}	7.72×10^{-5}	3.97×10^{-5}	1.15×10^{-2}	3.40×10^{-5}	1.85×10^{-5}	--	x	--	--

Table 4-7. Radionuclides Considered in PA — Continued

Radionuclide	Current Inventory Values			Values Reported in the CCA			Release Calculations (1)			
	Inventory at Closure (Ci)	EPA Units		Inventory at Closure (Ci)	EPA Units		Cuttings, Cavings, and Spall Release	Direct Brine Release	Salado Release	Culebra Release
		At Closure[4]	At 10,000 years		At Closure	At 10,000 years				
^{244}Pu	1.10×10^{-3}	4.44×10^{-6}	4.47×10^{-6}	1.51×10^{-6}	4.34×10^{-9}	1.26×10^{-8}	--	x	--	--
^{244}Cm	2.51×10^{3}	(3)	(3)	7.44×10^{3}	(3)	(3)	x	x	--	--
^{241}Pu	5.38×10^{5}	(3)	(3)	3.94×10^{5}	(3)	(3)	x	x	--	--
Percent of EPA Units at closure represented by nuclides in source term							99.98%	98.71%	48.95%	48.95%
Percent of EPA Units at 10,000 years represented by nuclides in source term							99.65%	99.99%	99.92%	99.92%

Source: Appendix TRU Waste, Section TRU Waste-2.0

1. See Section 6.3 for a discussion of scenarios analyzed by PA and the release pathways.
2. Pu-238 was included in the Salado transport calculations but the release to the Culebra was too low to merit calculation of its transport within the Culebra. The EPA unit percent total at closure increases to 98.71% with Pu-238 added; the percent at 10,000 years is unaffected.

3. Pu-241 and Cm-244 are not listed by Part 191 of the Code of Federal Regulations but are included because their daughters, ^{241}Am and ^{240}Pu, respectively, are significant to performance
4. At closure is decayed through 2033.

x indicates an isotope included in calculation.
c indicates isotopes that are combined for transport with isotopes having similar characteristics.

1 Approximately ~~99.4~~ *99.5* percent of the regulated RH-TRU activity at repository closure is
2 contributed by ^{137}Cs, ^{90}Sr, ^{239}Pu, ^{240}Pu, ^{241}Am, and ^{238}Pu (~~See Appendix WCA, Section WCA.8.2~~
3 *derived from data in TRU WASTE, Section TRU WASTE-2.0, Table TRU WASTE-9). The*
4 *same radionuclides were identified in the CCA as the largest contributors to the regulated CH-*
5 *TRU waste and RH-TRU waste activity at repository closure (see CCA Appendix WCA,*
6 *Section 8.2). Overall, activity for all TRU radionuclides has decreased from 3.44×10^6 Ci (at*
7 *2033) reported in the CCA to 2.48×10^6 Ci (at 2033) in the current inventory estimate. The*
8 *results for RH-TRU waste show variations in individual radionuclide activity and an overall*
9 *increase in reported activity since the CCA.*

10 The values presented in *Table 4-7*~~6~~ are used as input to the ~~performance assessment~~ *PA*
11 calculations. A more detailed examination of the programs prepared by ~~the~~ DOE to collect
12 supplemental radiological data ~~is~~*are* provided in Section 4.4.

13 In addition to the inventory in *Table 4-7*~~6~~*,* ~~the~~ DOE has determined the average radionuclide
14 inventory for each of the ~~569~~ *779 (693 CH-TRU waste streams and 86 RH-TRU waste streams)*
15 CH-TRU and ~~one~~ RH-TRU waste streams ~~in the conceptual models~~ (see Appendix ~~BIR,~~
16 ~~Revision 3, Appendix B-2~~ *DATA, Attachment F). In the conceptual model for PA, the*
17 *distribution of 693 CH-TRU waste streams and one RH-TRU waste stream (representing all of*
18 *86 the RH-TRU waste)* ~~The distribution of waste streams is~~ *are* randomly sampled in the
19 ~~performance assessment~~ *PA* ~~process~~ to determine releases due to inadvertent human intrusion.
20 This process is discussed in Section 6.4.12.4 and assumes that each container in the waste stream
21 has the average radionuclide inventory for that stream.

22 *4.2   Waste Components and Characteristics*

23 This section of the application is provided to document compliance with the provisions of ~~40~~
24 ~~CFR §~~ *Section* 194.24(b) and describes, in summary fashion,

25 • those components or characteristics of the waste that are most important in terms of their
26   impact on the performance of the WIPP disposal system and

27 • the limits imposed by ~~the~~ DOE on the significant components or characteristics of the
28   waste to ensure that ~~future~~ emplaced waste will behave in a manner that is consistent with
29   the inventory assumed for the performance calculations.

30 *4.2.1   Identification and Qualification*

31 ~~The following text is responsive to the criterion at 40 CFR § 194.24(b).~~

32 The waste characteristics and components expected to be most significant to performance are the
33 predominant radionuclides and their associated characteristics and components affecting actinide
34 mobility. These are summarized in Table 4-*8*~~7~~*; they are unchanged from the CCA*.

35

1 **Table 4-8~~7~~. Waste Characteristics and Components Expected to be Most Significant to**
2   **Performance**

Component	Characteristic ~~and Component~~	Reason for Significance
^{239}Pu, ^{240}Pu, ^{241}Am, ^{233}U, and ^{234}U	*Activity*	99 percent of EPA unit after 2,000 years
^{238}Pu	*Activity*	*Dominates* ~~dominates~~ EPA unit at early times
~~plutonium~~ *Pu* and ~~americium~~ *Am*	*Solubility* ~~of Pu and Am~~	~~large~~ *Large* EPA unit; mobility depends on solubility
^{238}U	*Activity*	*Very* ~~very~~ low activity; dilutes higher-activity uranium isotopes for brine-based releases
Iron	~~Iron~~*Redox Potential*	~~maintains~~ *Sustains* reducing environment so that lower, less soluble oxidation states of actinides predominate
Cellulosic material, plastic, rubber, nitrate, sulfate	*Nutrient for Microbes*	*Microbial* ~~microbial~~ nutrients that are metabolized to methane and several other gases, increasing gas pressure; formation of colloids
~~humic~~ *Humic* materials, cellulose breakdown products	*Colloid Formation*	~~form~~ *Formation of* humic colloids that sorb and transport actinides
~~nonferrous~~ *Nonferrous* metals	*Organic Complexation*	~~prevent increase~~ *Prevent increase* in actinide solubility by binding with ligands
~~waste~~ *Waste*	~~S~~shear ~~S~~strength	~~important~~ *Important* to spalling and cavings

Source: ~~Appendix WCA (Table WCA-12)~~ *Appendix TRU Waste, Section 2*

3 The waste unit factor is the number of millions of ~~curies~~ *Ci* of alpha-emitting TRU radionuclides
4 with half-lives longer than 20 years (~~40 CFR~~ Part 191 *of the Code of Federal Regulations*,
5 Appendix A). In the WIPP, ~~3.44~~*2.48*[3] million ~~curies~~ *Ci* of TRU waste will be in the repository at
6 closure, so the waste unit factor is ~~3.44~~*2.48*. The radionuclides that contribute to the waste unit
7 factor are based on an analysis (see Appendix ~~WCA.8.2~~ *TRU WASTE, Section TRU WASTE-*
8 *2.0*) of the radionuclide inventory in ~~Revision 3 of the TWBIR (Appendix BIR)~~ *Appendix*
9 *DATA, Attachment F* and are *presented in Table 4-9*~~8~~ (decayed to the end of 2033). *The*
10 *radionuclide contributions to the waste unit factor from the CCA are also presented in Table*
11 *4-9*~~8~~*.* Waste characteristics and components with an insignificant impact on performance are
12 summarized in Table 4-*10*~~9~~*. This table remains unchanged from CCA Table 4-9.*

13

---

[3] *The value for the waste unit factor (WUF) in the CCA was inconsistently described; Chapter 4, Section 4.2.1 correctly listed the WUF that was used in the CCA PA as 3.44. CCA Appendix WCA Sections 1.4.2 and WCA Attachment WCA.8.1 incorrectly stated the 1995 decayed value of 4.07 was used in the CCA PA, however the preface to Attachment WCA.8.2 identified and corrected the error. During the EPA's review of the CCA, EPA required DOE to recalculate a new WUF of 3.59 that was ultimately included in the EPA's PAVT (EPA 1998). After the certification, the DOE incorporated the PAVT WUF value of 3.59 in the compliance baseline through an EPA approved change request (EPA 2002).*

1   **Table 4-8. Radionuclides That Contribute to the Waste Unit Factor**

Nuclide	Half-Life (years)	Inventory at Closure (curies)	Percent of Waste Unit
^{241}Am	432.7	4.48×10^5	11
^{243}Am	7370	32.6	8.01×10^{-4}
^{249}Cf	351	.0685	1.69×10^{-6}
^{251}Cf	900	3.78×10^{-3}	9.28×10^{-6}
^{243}Cm	29.1	101.7	2.50×10^{-3}
^{245}Cm	8500	115	2.82×10^{-3}
^{246}Cm	4760	.102	2.51×10^{-6}
^{247}Cm	1.56×10^7	9.51×10^{-9}	7.88×10^{-14}
^{248}Cm*	3.48×10^5	3.21×10^{-2}	9.1×10^{-7}
^{237}Np	2.14×10^6	.0369	1.39×10^{-3}
^{238}Pu	87.7	56.4	64.1
^{239}Pu	2.41×10^4	2.61×10^5	19.5
^{240}Pu	6560	2.15×10^5	5.28
^{242}Pu	3.75×10^5	1170	2.87×10^{-2}
^{244}Pu	8.0×10^7	1.50×10^{-6}	3.68×10^{-11}
Total		4.07×10^6	

Source: Appendix WCA (Table WCA-5).
* This number differs slightly from that in Appendix WCA (Section WCA.8.2) as a result of more recent information.

2 *4.2.2   Repository Limits*

3 This *The* following discussion ~~is responsive to~~ *describes* the criteria ~~at 40 CFR §~~ *in Sections*
4 194.24(c)(1) and ~~40 CFR §~~ 194.24(c)(2).

5 *Waste c*~~C~~omponents are the controlling factors for the *waste* characteristics**.** ~~; therefore any~~
6 *Therefore,* limits imposed on the waste components necessarily serve to limit the waste
7 characteristics. In the case where a characteristic is benign with respect to repository
8 performance, no control of the corresponding component is necessary and no limits need be
9 imposed on that component. Conversely, should repository performance be sensitive to a
10 particular waste characteristic, then control of the corresponding component is mandated and
11 limits are established to restrict the maximum or minimum amounts of that component allowed
12 for disposal.

13 Based on the ~~performance assessment~~ *PA* calculations and the rationale ~~developed~~ *described* in
14 Appendix ~~WCL~~ *TRU WASTE,* Table 4-*11*~~10~~ identifies the characteristics of the components for
15 which ~~assay~~ *determination* prior to emplacement is required. Table 4-*11*~~10~~ also lists any
16 applicable repository-based emplacement limit*s* for the components. Discussions of the rationale
17 for the proposed assaying and emplacement limits for each component *are presented* in

1   *Table 4-9. Radionuclides That Contribute to the Waste Unit Factor*

Nuclide	Half-Life (years)	Current Inventory Values		Values Reported in the CCA[(1)]	
		Inventory at Closure (Ci)	Percent of Waste Unit at Closure	Inventory at Closure (Ci)	Percent of Waste Unit at Closure
^{241}Am	4.33×10^2	4.58×10^5	1.82×10^1	4.88×10^5	1.42×10^1
^{243}Am	7.37×10^3	2.17×10^1	8.63×10^{-4}	3.25×10^1	9.45×10^{-4}
^{249}Cf	3.51×10^2	7.24×10^{-2}	2.88×10^{-6}	6.38×10^{-2}	1.85×10^{-6}
^{251}Cf	9.00×10^2	5.10×10^{-4}	2.03×10^{-8}	3.67×10^{-3}	1.07×10^{-7}
^{243}Cm	2.91×10^1	4.07×10^{-1}	1.62×10^{-5}	2.07×10^1	6.02×10^{-4}
^{245}Cm	8.50×10^3	1.92×10^{-2}	7.62×10^{-7}	1.15×10^{-2}	3.34×10^{-7}
^{246}Cm	4.76×10^3	2.22×10^0	8.80×10^{-5}	1.02×10^{-1}	2.97×10^{-6}
^{247}Cm	1.56×10^7	9.45×10^0	3.75×10^{-4}	9.51×10^{-9}	2.76×10^{-13}
^{248}Cm	3.48×10^5	9.32×10^{-2}	3.70×10^{-6}	3.72×10^{-2}	1.08×10^{-6}
^{237}Np	2.14×10^6	1.01×10^1	4.00×10^{-4}	6.49×10^1	1.89×10^{-3}
^{238}Pu	8.77×10^1	1.25×10^6	4.98×10^1	1.94×10^6	5.64×10^1
^{239}Pu	2.41×10^4	6.65×10^5	2.64×10^1	7.95×10^5	2.31×10^1
^{240}Pu	6.56×10^3	1.08×10^5	4.30×10^0	2.14×10^5	6.22×10^0
^{242}Pu	3.75×10^5	2.71×10^1	1.08×10^{-3}	1.17×10^3	3.40×10^{-2}
^{244}Pu	8.00×10^7	1.10×10^{-3}	4.38×10^{-8}	1.51×10^{-6}	4.39×10^{-11}
Total	---	2.48×10^6	9.86×10^1	3.44×10^6	9.99×10^1

Source: Appendix TRU WASTE, Section TRU WASTE-2.0.
(1) Radionuclide activities and the WUF were reported with conflicting values in several places in the CCA. The values used in this table were the actual values used in the performance assessment for the CCA as recorded in the PAPDB.

2   **Table 4-~~10~~9. Waste Characteristics and Components Expected to be *Ins*ignificant**

Characteristics and Component	Reason for insignificant impact
~~radionuclides~~ *Radionuclides* other than those in Table 4-~~8~~7	EPA unit is negligible fraction of total, even with ingrowth
~~substances~~ *Substances* that may affect pH[1]	pH is buffered by MgO backfill
~~substances~~ *Substances* that produce CO_2[1]	CO_2 is removed by reaction with MgO backfill
~~intrinsic~~ *Intrinsic* and mineral fragment colloids	~~fraction~~ *Fraction* of actinides mobilized by these colloids is insignificant
~~organic~~ *Organic* ligands	~~removed~~ *Removed* by binding with Mg and nonferrous metal
~~heat~~ *Heat* generated by exothermic reactions	~~heats~~ *Heats* of formation are small and thermal mass of repository is large so that temperature rise is negligible
~~fluid~~ *Fluid* in the waste	~~negligible~~ *Negligible* compared to brine volume

Source: Appendix *TRU WASTE* ~~WCA (Table WCA-13)~~
[1] These components are significant for gas generation, but not for actinide solubility.

3

4

1 **Table 4-1~~0~~*1*. Repository-Based Emplacement Limits Related to**
2 **~~Performance Assessment~~ *PA***

Waste Components	Associated Waste Characteristics	Components Requiring Quantification	Emplacement Limits
radionuclides	radioactivity at closure radioactivity after closure solubility colloid formation reduction-oxidation state	^{241}Am ^{238}Pu ^{239}Pu ^{240}Pu ^{242}Pu ^{233}U ^{234}U ^{238}U ^{90}Sr ^{137}Cs	none[*1*a]
ferrous metals (iron)	reduction-oxidation potential H_2 ~~has~~ *gas* generation complexing with organic ligands	none	minimum = 2×10^7 kilograms (amount from containers)[*2*b]
cellulos~~e~~*ic*, plastic~~s~~, rubber *materials*	gas generation humic colloids (see below) gas generation	sum of emplaced components	maximum = 2.*2* $\times 10^7$ kilograms[*3*e]
sulfates	gas generation	none	none[*4*d]
nitrates	gas generation	none	none[*4*d]
solid components	particle size effective shear resistance to erosion tensile strength	none	none
free ~~water~~*liquid* emplaced with waste	gas generation	none	maximum = 1684 cubic meters for CH-TRU (limit of 1 percent total waste volume as set by the WAC) [e]
humic substances	radionuclide-bearing humic colloids	none	none
nonferrous metals (metals other than iron)	bind with organic ligands and prevent increased solubility	none	minimum = 2×10^3 kilograms[*5*f]
organic ligands	solubility	none	none[*4*d]

Source: Appendix ~~WCL~~ *TRU WASTE, Section TRU WASTE-3.0*

[*1*a]   Inventory curie content will be tracked.

[*2*b]   Minimum set to ensure sufficient reactants for reducing radionuclides to lower and less soluble oxidation states. ~~Average density for CH-TRU container steel of 139 kilograms per cubic meter multiplied by the design basis value of 168,485 cubic meters.~~

[*3*e]   Maximum set to ensure sufficient MgO backfill is available to react with CO_2 produced.

[*4*d]   For the current waste generation processes that are documented in the TWBIR.

[e]   ~~1 percent of the design basis values for CH-TRU of 168,485 cubic meters.~~

[*5*f]   Minimum quantity for complexing with organic ligands (see Appendix ~~SOTERM, Section SOTERM.5~~ *PA, Attachment SOTERM*).

4

1 Appendix *TRU WASTE* ~~WCL~~. All of the components identified *in CCA Appendix WCA and*
2 *Appendix TRU WASTE, Section TRU WASTE.2-0* were found to be insignificant to disposal
3 system performance. Therefore, it is not necessary to establish *additional* container-based
4 emplacement limits for these components. ~~other than those already imposed through the CH-~~
5 ~~TRU Waste Acceptance Criteria (WAC) (see next section)~~.

6 Table 4-*12*~~11~~ is a supplement to Table 4-*11*~~10~~; that is, it lists the repository limits imposed by the
7 LWA ~~(U.S. Congress 1992b)~~. Collectively, Tables 4-*11*~~10~~ and 4-*12*~~11~~ define the WIPP
8 repository-based emplacement limits on the waste.

9 *Since the first waste shipment arrival at the WIPP, DOE has tracked the quantities of*
10 *materials identified in Tables 4-11 and 4-12 that have been emplaced in the repository. The*
11 *quantities of these materials emplaced in WIPP since its opening through September 30, 2002,*
12 *are listed in Tables 4-13 and 4-14.*

13 *4.2.3   Waste Container Limits*

14 Waste limits have been established by ~~the~~ DOE as part of the WIPP's design development and
15 by the WIPP LWA. ~~Table 4-12 identifies waste container limits.~~ *Waste container limits*
16 *relevant to the requirements of the WIPP LWA are identified in Table 4-15.* The *CH-TRU*
17 *Waste Acceptance Criteria (*WAC*)* ~~is a compilation of criteria that~~ restrict the physical,
18 chemical, and radiological properties of the waste to mitigate conditions that will have adverse
19 impacts on human health and the environment. ~~The current WIPP WAC (DOE 1996a) does not~~
20 ~~contain restrictions associated with or driven by performance assessment results.~~

21 ~~The WAC is founded on transportation requirements, disposal operations safety criteria as~~
22 ~~documented in the Safety Analysis Report (SAR) (DOE 1995d), regulatory compliance~~
23 ~~requirements and several other drivers (depicted in Figure 4-4)~~, ~~including the WAP, the Safety~~
24 ~~Analysis Report, for Packaging (SARP), and this application. Only those wastes that meet~~
25 ~~established acceptance criteria and obtain waste stream profile approval from the CAO will be~~
26 ~~emplaced in the WIPP disposal system. Waste forms that do not meet these criteria will require~~
27 ~~treatment and/or repackaging prior to WIPP certification.~~

28 ~~Application of the WAC extends to both CH-TRU and RH-TRU waste proposed for disposal in~~
29 ~~the WIPP. The current WAC limits shown in Table 4-12 are on a waste container basis.~~ The
30 *DOE* ~~WAC~~ requires the ~~generator~~ *TRU waste sites* to prepare a waste-certification ~~program~~ *plan*
31 that lists the methods and techniques used to determine compliance with the *CH-TRU* WAC and
32 the ~~quality assurance~~ QA *program (see Appendix QAPD-2004)*. ~~and~~ *This includes QA and*
33 quality control criteria that are applied to the generator's waste certification program. Each
34 participating *TRU waste* site is responsible for developing and implementing ~~site~~-specific TRU
35 waste program documents (plans) that address all activities pertaining to TRU waste
36 characterization, certification, packaging, and transportation of TRU waste to the WIPP. These
37 plans include the TRU Waste Certification Plan and associated QA plan, the TRUPACT-II
38 Authorized Methods for Payload Control and associated QA plans, and the TRU waste
39 characterization QAPjP. Methods of compliance with each criterion and requirement are
40 documented or specifically referenced and include procedural and administrative controls.

1   **Table 4-1~~2~~1. Repository-Based Emplacement Limits Imposed by the LWA**

Waste Components	Emplacement Limits
Total Capacity (CH- and RH-TRU)	6.2 million ~~cubic feet~~ *ft*^{3} (175,564 ~~cubic meters~~ *m*^{3})
RH-*TRU* waste total ~~curies~~ *Ci*	5.1 million ~~curies~~ *Ci* ($\sim$18.9 $\times$ 10^{16} Becquerels)
RH-TRU waste total dose rate	*No more than five percent by volume of RH TRU waste may exceed 100 rems per hour*

2   *Table 4-13. Quantities of Radionuclides Emplaced in the Repository as*
3   *of September 30, 2002[1,2]*

4   *NR=Not reported or reported at values less than 10^{-13}*

Radionuclide	Quantity (Ci)	Radionuclide	Quantity (Ci)
^{227}Ac	3.64×10^{-4}	^{147}Pm	NR
^{241}Am	1.17×10^{5}	^{238}Pu	5.64×10^{3}
^{243}Am	4.81×10^{-3}	^{239}Pu	1.38×10^{5}
^{14}C	NR	^{240}Pu	3.10×10^{4}
^{249}Cf	NR	^{241}Pu	4.37×10^{5}
^{251}Cf	NR	^{242}Pu	2.96×10^{0}
^{252}Cf	NR	^{244}Pu	NR
^{243}Cm	NR	^{226}Ra	7.88×10^{-6}
^{244}Cm	NR	^{228}Ra	NR
^{245}Cm	NR	^{79}Se	NR
^{246}Cm	NR	^{151}Sm	NR
^{247}Cm	NR	^{121}Sn^{m}	NR
^{248}Cm	NR	^{126}Sn	NR
^{60}Co	3.47×10^{-7}	^{90}Sr	NR
^{135}Cs	NR	^{99}Tc	NR
^{137}Cs	3.41×10^{-9}	^{229}Th	NR
^{129}I	NR	^{230}Th	2.41×10^{-5}
^{40}K	2.87×10^{-5}	^{232}Th	2.61×10^{-6}
^{22}Na	5.34×10^{-6}	^{232}U	NR
^{59}Ni	NR	^{233}U	2.73×10^{-1}
^{63}Ni	NR	^{234}U	1.26×10^{0}
^{237}Np	4.00×10^{-1}	^{235}U	1.22×10^{-1}
^{231}Pa	5.04×10^{-4}	^{236}U	NR
^{210}Pb	NR	^{238}U	6.53×10^{0}
^{107}Pd	NR	^{93}Zr	NR

Source: WWIS
[1] These data were taken from the WWIS and differ slightly from the data reported for WIPP in Appendix DATA Attachment F. This is because all data in Appendix DATA Attachment F have been decayed to a single base year 2001 (i.e., decayed through 2001) while the data provided in the WWIS are reported values based on assay and have not been decayed to a single base year.
[2] Isotopes other than the 10 listed in Table 4-11 are not required to be tracked unless required by DOT regulations.

5

6

Table 4-14. Quantities of Non-Radionuclide Waste Components Emplaced in the Repository as of September 30, 2002, and Associated Emplacement Limits

Waste Components	Quantity	Emplacement Limit
Ferrous metal (iron)	2,487,261 kilograms	Minimum = 2×10^7 kilograms
Cellulosic, plastic, and rubber materials	700,981 kilograms	Maximum = 2.2×10^7 kilograms
Nonferrous metals (metals other than iron)	31,059 kilograms	Minimum = 2×10^3 kilograms

Source: WWIS

Table 4-12. Container-Based Limits Imposed by the WAC

Waste Component or Characteristic	Limit
CH and RH waste criticality	<200 fissile gram equivalents (FGE) per 55-gallon drum <325 FGE per standard waste box (SWB)
CH and RH waste ^{239}Pu equivalent activity	Untreated Waste 80 plutonium equivalent curies (PE-Ci) per drum <130 PE-Ci per SWB <1800 PE-Ci per drum[1] Solidified/Vitrified Waste £1800 PE-Ci/55-gallon drum
CH and RH waste surface dose rate	<200 mrem/hr (CH) <1000 rem/hr (RH)
RH waste thermal power	Report if 70.1 watts/cubic feet
RH waste curies per liter	23 curies/liter
Liquids or aqueous waste	No liquid wastes <2 liters total residual liquid per 55-gallon drum <8 liters total residual liquid per SWB <inch in the bottom of any container
Explosives	None
Compressed gases	None
Pyrophoric materials	<1% radionuclide pyrophorics No nonradionuclide pyrophorics
Polychlorinated Biphenyls	<50 ppm

Overpacked in a SWB or a ten-drum overpack

Table 4-15. Container-Based Limits

Waste Component or Characteristic	Limit
CH-TRU and RH-TRU waste activity	> 100 nCi/gram of waste
CH-TRU waste surface dose rate	≤ 200 mrem/hour (CH)
RH-TRU waste surface dose rate	≤ 1000 rem/hour (RH)
RH-TRU waste Ci per liter	23 Ci/liter averaged over the container
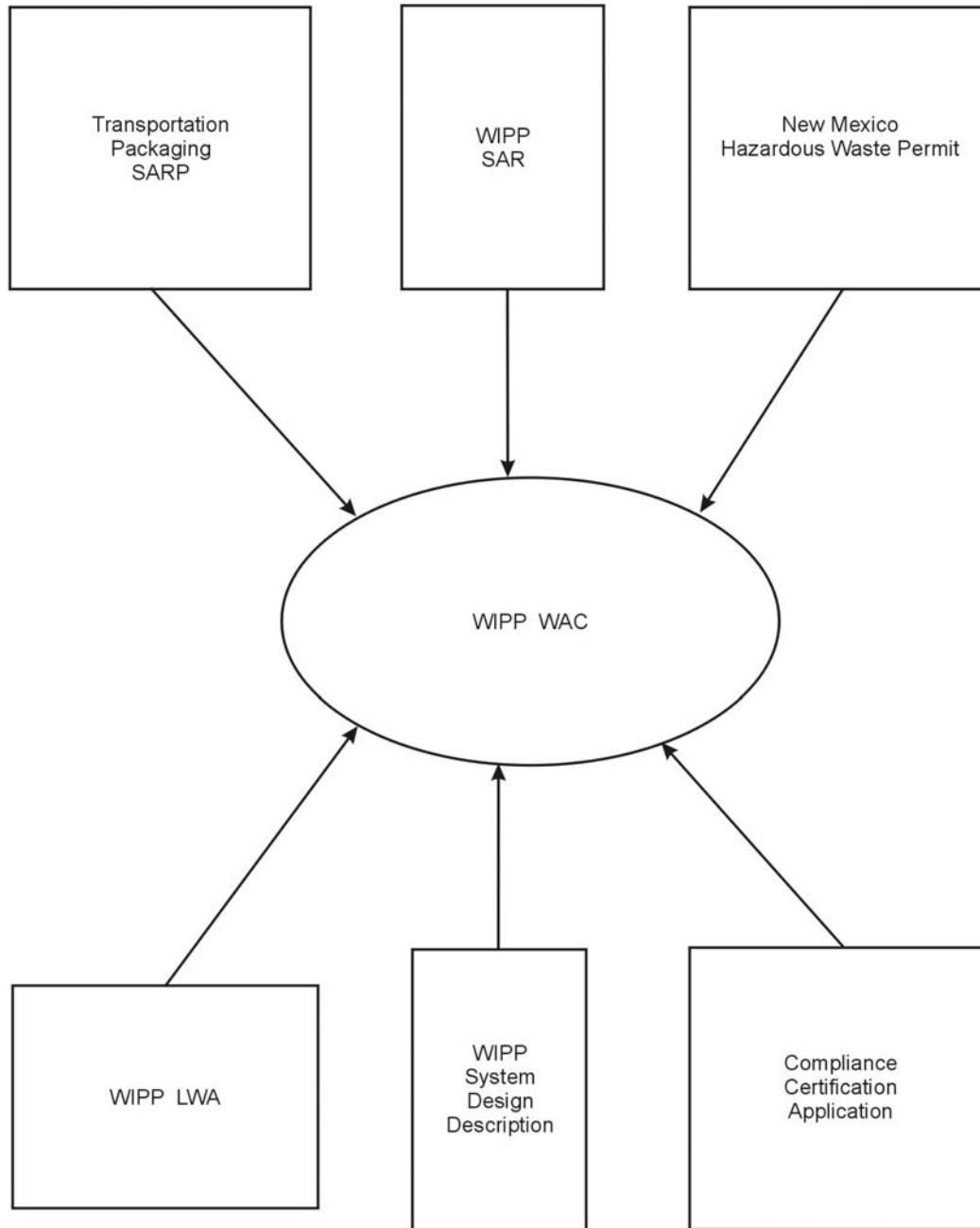
Note: Adapted from Figure 2-1, WAC Revision 5.

CCA-082-2

1
2 **Figure 4-4. Origins of the WAC**

3 *Based on the acceptance of the site-specific waste characterization and QA program, the* The
4 ~~DOE~~ ~~CAO~~ *CBFO* Manager is responsible for granting and revoking the *program certification*
5 *that allows the TRU waste site to characterize and to ship waste to WIPP*. ~~authority to a site to~~
6 ~~certify TRU waste to the WAC.~~ The ~~CAO~~ *CBFO* performs certification audits of the *TRU*
7 *waste* sites to assess the implementation of and compliance with the approved plans. On the

1. basis of acceptable results of the certification audits, the DOE grants TRU waste certification
2. authority and transportation authority to the *TRU waste* site. *DOE provides* ~~C~~continuing
3. oversight of ~~participating~~ *TRU waste* sites ~~is provided by the DOE~~ through periodic audits of
4. TRU waste characterization, certification, and transportation activities.

5. *Consistent with the provisions of section 194.8, the EPA also has a role in the approval*
6. *process. The EPA determines compliance with requirements for site-specific QA programs.*

7. ~~A waste-stream profile form (contained in the WAP) is used by generator site personnel to notify~~
8. ~~the WIPP that a waste stream has been identified and characterized. The data described on this~~
9. ~~form are used by the WIPP as the basis for acceptance of the waste characterization process~~
10. ~~identified for each container belonging to this waste stream. The~~ *CH-TRU* WAC
11. ~~establishes~~*provides the* limits for the physical, radiological, and chemical characteristics of the
12. waste in addition to specifications for the waste packaging. *Waste that is characterized*
13. *according to and approved program and meets the requirements of the CH-TRU WAC can be*
14. *shipped to the WIPP. Additional information regarding the TRU waste site waste*
15. *characterization and QA program requirements is provided in Appendix TRU WASTE.*

16. ~~Once the DOE has obtained necessary operating permits and certifications, a~~ *A*ppropriate
17. changes to the *CH-TRU* WAC will be published to reflect new restrictions and conditions
18. imposed by permits and certifications. These changes will be communicated to the ~~generator~~
19. ~~and storage~~ *TRU waste* sites as a change to the *CH-TRU* WAC. Those retrievably stored or
20. newly generated waste streams that do not meet the ~~current disposal~~ *CH-TRU* WAC, however,
21. may require processing (including repackaging and/or treatment) until *compliance*~~certification~~
22. can be attained. Any such processing is the responsibility of the site proposing to ship the waste
23. to the WIPP. TRU waste that has been characterized in accordance with prior revisions of the
24. *CH-TRU* WAC ~~and the QAPP~~ may be reconciled with current requirements. This reconciliation
25. is documented and filed at the *TRU waste* site.

26. *Changes related to waste characterization documents have occurred since the initial*
27. *certification. Waste characterization elements of the QAPP (TRU Waste Characterization*
28. *Quality Assurance Program Plan, CAO [CBFO] 94-1010) have been incorporated into recent*
29. *revisions of the CH-TRU WAC, the WAP, and the QAPD. The QAPP and the TRU Waste*
30. *Characterization Sampling and Analysis Methods manual (DOE 1995b) have been cancelled.*

31. **4.3   Waste Controls**

32. This section describes those processes that ensure compliance with the limits for CH-TRU *waste*
33. and RH-TRU waste to be emplaced in the WIPP disposal system.

34. *4.3.1   Load Management*

35. The following ~~discussion~~ *discusses* ~~is responsive to the criteria at 40 CFR §~~ *compliance with*
36. *Section* 194.24(d) *and* (f).

37. Load management is the process of controlling the shipment and emplacement of TRU waste in
38. order to achieve a predetermined (that is, nonrandom) distribution of waste within the disposal

1 system. ~~An important reason for considering the impact of~~ *DOE must assess whether the* spatial
2 distribution of waste in the repository ~~is because of the~~ *could have* significance ~~of~~ *for* human
3 intrusion on long-term repository performance. As described in Section 6.4.12, drilling events
4 are assumed to be random in time and space. The location of each intrusion borehole within the
5 waste disposal region is sampled randomly. Each intrusion borehole that penetrates waste may
6 encounter CH-TRU waste or RH-TRU waste. For calculating direct releases to the accessible
7 environment, containers are assumed to be placed in the WIPP from the various ~~569~~ waste
8 streams which comprise CH-TRU waste in a random manner. In calculating direct releases
9 resulting from a drill bit penetrating containers, each of the three stacked containers can come
10 from different waste streams and have different activity loading. As described in Section 6.5,
11 direct release from cuttings and cavings are the most important releases in assessing compliance
12 with the quantitative containment requirements in ~~40 CFR §~~ *Section* 191.13(a) *for both the CCA*
13 *and CRA-2004.*

14 The CCDFs presented in Section 6.5 are constructed by estimating cumulative radionuclide
15 releases to the accessible environment for 10,000 different possible futures. The estimated
16 release for each future includes the randomly sampled waste streams for each of the various
17 intruding boreholes that comprise that sampled future. A sampling of 10,000 futures is large
18 enough that the relatively low probability combination of three of the waste streams with higher
19 activity loading occurring in a single drilling event is captured in the CCDFs presented in
20 Section 6.5. As described in Section 6.5, the CCDF is not impacted by sampling uncertainty so
21 the assumption of random emplacement of containers is not important to the location of the
22 CCDF and a load management plan is not necessary to support ~~performance assessment~~ *PA*
23 assumptions.

24 *In support of CRA-2004, DOE investigated the impact of non-homogeneous patterns of waste*
25 *emplacement in the repository. The investigation verified that non-homogeneous*
26 *emplacement will not have a significant impact on PA. The results of the investigation are*
27 *reported in Chapter 6.0.*

28 *4.3.2 WIPP Waste Information System*

29 The following *discusses compliance with* ~~discussion is responsive to~~ the criteria at ~~40 CFR §~~
30 *Sections* 194.24(c)(4), ~~and 40 CFR § 194.24~~(c)(5), and ~~those at 40 CFR § 194.24~~(e).

31 The WWIS is ~~a computerized~~ *an electronic* data management system used by ~~the~~ *DOE* ~~WIPP~~ to
32 gather, store, and process information pertaining to TRU waste destined for or disposed at the
33 WIPP. The system supports those organizations ~~who~~ *that* have responsibility for managing TRU
34 waste by collecting information into one source and providing data in a uniform format that has
35 been verified or certified as being accurate. The WWIS is used to store ~~all~~ information
36 pertaining to characterization, certification, and emplacement of waste at the WIPP. Information
37 ~~for~~ *in* this system is supplied by the ~~generator~~ *TRU waste* sites ~~of TRU waste~~ and the WIPP
38 facility. Figure 4-*2*~~5~~ depicts the process and flow of data from the *TRU waste* sites to the
39 WWIS.
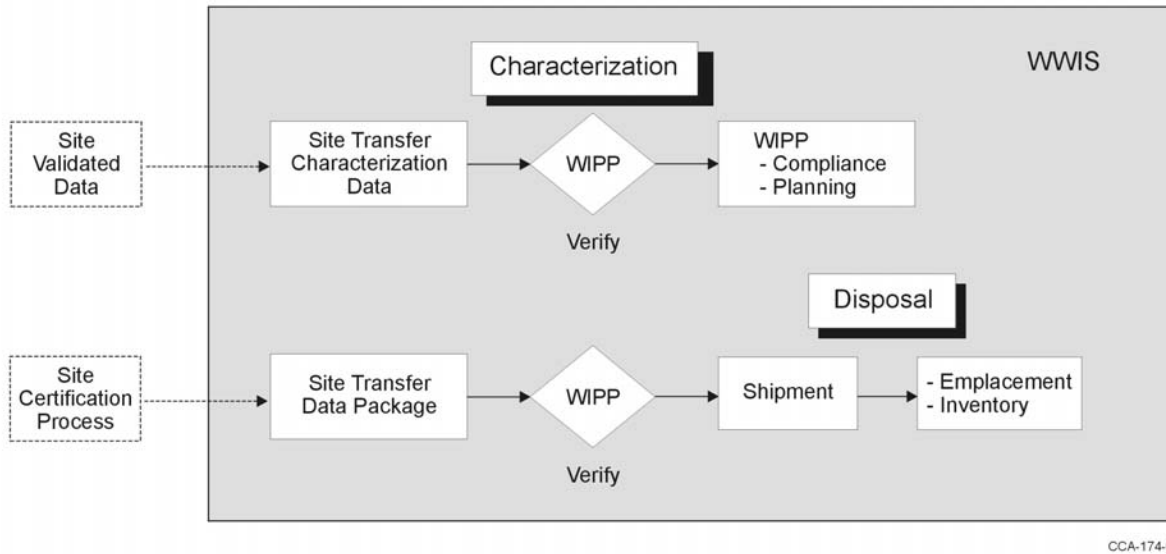
1
2   **Figure 4-_2_~~5~~. WIPP Waste Information System Process and Data Flow**

3   *At the time of the CCA, the* ~~The~~ WWIS use_d_~~s~~ the Oracle (Version 7) database management
4   system that follow_ed_~~s~~ American National Standards Institute (ANSI) standard query language.
5   The database management system ~~resides~~ *was resident* on a Digital Equipment Corporation
6   hardware platform*,* ~~and is~~ compliant with the majority of existing computer hardware throughout
7   the DOE complex. UNIX ~~is~~ *was* the operating system and support_ed_~~s~~ multiuser and multitasking
8   environments. *The current computing system remains unchanged except that the software*
9   *employed now is Oracle Version 9. Additional computing system upgrades may be*
10   *implemented in the future.*

11   *Minor upgrades and improvements have been made to the WWIS since the EPA certification.*
12   *Minor changes to several documents related to the design and operation of the system have*
13   *also been made. All changes improved the system or updated information.* The WWIS ~~shall~~
14   ~~be~~ *is* available seven days a week, 24 hours a day except for periodic maintenance and ~~shall~~
15   support_s_ the maximum number of simultaneous users determined by the database management
16   system license agreement and the operating system license agreement. The network
17   communication protocol of the WWIS is Transmission Control Protocol/Internet Protocol
18   (TCP/IP). Other features ~~that distinguish the WWIS from its predecessor~~ include automatic
19   limit, range, and QA checks; automatic report generation; and compliance with QA requirements
20   for computer software for nuclear facility applications (American Society of Mechanical
21   Engineers [ASME], Nuclear Quality Assurance [NQA]-1, NQA-2, Part 2.7, and NQA-3 [ASME
22   1989a, 1989b, and 1989c ~~in the Bibliography~~]).

23   The following WWIS documentation has been identified as necessary and sufficient to document
24   the software lifecycle:

25   •   WWIS Evaluation & Recommendation – provides an evaluation of hardware and
26   software configurations for the WWIS and recommends an approach for implementation.

- WWIS Software Quality Assurance Plan – identifies and defines the standards and methodologies required to ensure conformance to accepted quality standards during the development, maintenance, and operation of the WWIS. This plan ensures that products conform to established technical requirements.

- WWIS Software Verification and Validation Plan – describes the criteria for verification and validation activities for the requirements, design, testing, and all necessary documentation.

- WWIS Software Requirements Specification – defines the requirements essential to the WWIS based on the WWIS Functional and Operational Requirements Document. All requirements shall be internally consistent and verifiable through demonstration, analysis, or testing.

- WWIS Software Design Description – defines the major features of the WWIS including the operating environment, databases, tables, external and internal interfaces, overall structure, sizing, modeling, and system throughput.

- WWIS Software Configuration Management Plan – describes the methods used for identifying software configuration items, controlling and implementing changes, and recording and reporting change implementation status.

- WWIS Security Plan – details the information for handling the security needs of the system (data, software, and hardware). This plan also describes password and access control procedures.

At the time of the CCA, ~~The~~*the* DOE ~~has~~ identified more than 130 data fields for inclusion in the WWIS. An alphabetical listing and description of these data fields is found in ~~Appendix C13 of Appendix~~ *the* WAP *(NMED 2002).* The majority of these data fields are considered pertinent to demonstrate compliance with TRU waste transportation and disposal requirements*. These listings are now updated and maintained in the WWIS User's Manual (DOE 2001).*~~, those data fields identified as relevant to this application include the following:~~

- *Radionuclides present in container*

- *Activity of individual radionuclides*

- *Uncertainty associated with the activity of individual radionuclides*

- *Mass of the individual radionuclides*

- *Uncertainty associated with the mass of individual radionuclides*

- *Estimated weight of waste material parameters*

- *Date of assay*

1   • ~~assay characterization method~~

2   • ~~assay date~~

3   • ~~disposal date~~

4   • ~~nondestructive examination~~

5   • ~~^{239}Pu fissile gram equivalent~~

6   • ~~radionuclide activity~~

7   • ~~radionuclide activity uncertainty~~

8   • ~~radionuclide mass~~

9   • ~~radionuclide mass uncertainty~~

10   • ~~TRU alpha activity~~

11   • ~~TRU alpha activity uncertainty~~

12   • ~~verification data~~

13   • ~~verification method~~

14   • ~~visual examination of container~~

15   • ~~WAC certification data~~

16   • ~~WMPs~~

17   • ~~WMC~~

18 To ensure compliance with the data requirements, personnel at the WIPP review the ***WWIS***
19 ***information on each*** data package for completeness and adequacy before notifying the shipping
20 site of acceptance. Thus, the WWIS becomes an integral part of the waste information screening
21 process described in the WAP.

4.3.3   *Quality Assurance*

23 The implementation of a formal ~~quality assurance~~ *QA* program demonstrates the commitment of
24 DOE to perform all work activities and operations to the highest standards of quality. DOE has
25 established an effective QA program that complies with applicable sections of NQA-1, NQA-2
26 (Part 2.7), and NQA-3. The management controls defined by the various ~~quality assurance~~ *QA*
27 plans and procedures ensure that all work is planned, documented, performed under controlled
28 conditions, and periodically assessed to establish work item quality and process effectiveness
29 and to promote improvement. The complexity, inherent risk, and significance of the work to the

1 overall project and to public safety are key factors in determining applicable quality management
2 requirements. Internal and external organizational interfaces and responsibilities are described in
3 detail in Chapter 5.0.

4 ~~The QA requirements for TRU waste characterization are contained in the DOE TRU Waste~~
5 ~~Characterization QAPP. The QAPP is applicable to all DOE TRU waste generator sites that~~
6 ~~anticipate characterizing TRU waste. Participating sites must follow acceptable analytical~~
7 ~~methods as specified in the Transuranic Waste Characterization Sampling and Analysis Methods~~
8 ~~manual (DOE 1995c). Included in the QAPP for each method is a description of the specific~~
9 ~~performance requirements. These are referred to as quality assurance objectives (QAOs). Should~~
10 ~~modifications to the approved test methods be necessary, whether for personnel protection from~~
11 ~~radiation or to implement an improved methodology, these modifications are to be fully~~
12 ~~documented and approved in accordance with the QAPP and the Sampling and Analysis~~
13 ~~Methods Manual.~~

14 ~~The QAPjPs developed at each generator and storage site describe the characterization activities~~
15 ~~that are performed in conformance with the QA requirements specified in the QAPP. The DOE~~
16 ~~conducts annual certification audits, supplemented by surveillances to ensure that the sites~~
17 ~~comply with their approved site-specific QAPjPs. Figure 4-6 shows the quality assurance~~
18 ~~document hierarchy for waste characterization.~~

19
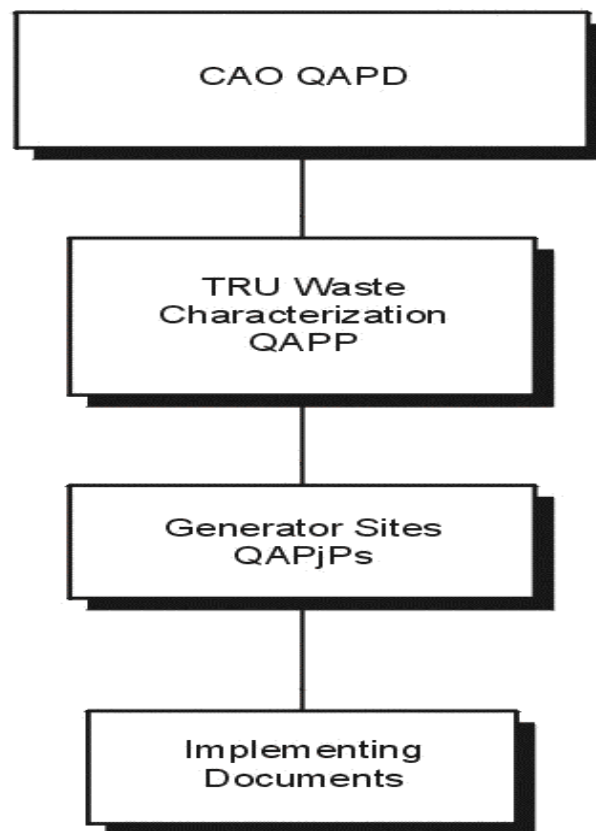
20 **~~Figure 4-6. QA Document Hierarchy for Waste Characterization.~~**

1 ~~The QAOs for the nondestructive assay (NDA) of CH-TRU waste are listed in the QAPP and are~~
2 ~~intended to establish minimum performance requirements for the approved types of~~
3 ~~measurement systems. The QAOs include criteria for precision, accuracy, minimum detectable~~
4 ~~concentration, completeness, and total uncertainty. All measurements of activity for CH-TRU~~
5 ~~waste must have a precision bounded by the range of values in the QAOs established in the~~
6 ~~QAPP. Only those containers that can be assayed with a precision falling within these bounding~~
7 ~~values can be accepted for disposal at the WIPP.~~

8 *The DOE TRU Waste Characterization QAPP (DOE 1995a) and the TRU Waste*
9 *Characterization Sampling and Analysis Methods Manual (DOE 1995b) were replaced as of*
10 *November 26, 1999. Figure 4-3 shows the revised QA document hierarchy for waste*
11 *characterization.*

12 Additional information regarding the quality assurance and quality controls used in ascertaining
13 the waste description is given in Chapter 5.0.

14

```
        ┌─────────────────────────┐
        │                         │
        │         CBFO            │
        │         QAPD            │
        │                         │
        └─────────────────────────┘
                     │
        ┌─────────────────────────┐
        │                         │
        │     Generator Sites     │
        │         QAPjPs          │
        │                         │
        └─────────────────────────┘
                     │
        ┌─────────────────────────┐
        │                         │
        │      Implementing       │
        │       Documents         │
        │                         │
        └─────────────────────────┘
```
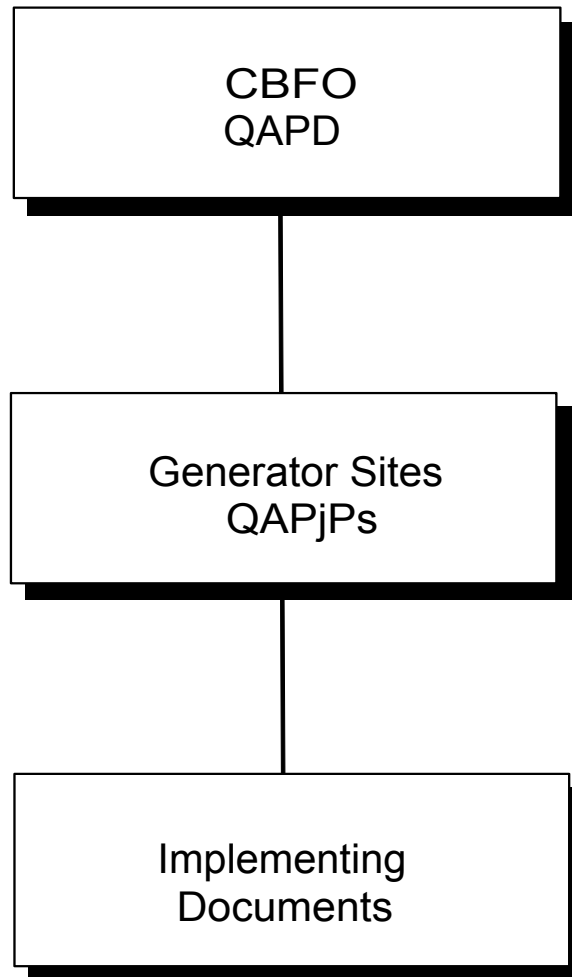
15
16 *Figure 4-3. QA Documents Hierarchy*

1 4.3.3.1   Performance Demonstration Programs

2 *Another aspect of the waste-characterization QA process that has changed is related to the*
3 *Performance Demonstration Program (PDP). The program evaluates the capability of sites to*
4 *perform waste characterization within acceptable limits. Initially, participating laboratories*
5 *were required to participate in the PDP twice per year. The CBFO has reduced the required*
6 *frequency from twice per year to once per year. The CBFO described this change to the EPA*
7 *in correspondence dated November 10, 1998, and April 22, 1999. Based on this information,*
8 *the EPA determined that the changes reported did not require a modification, suspension, or*
9 *revocation of the initial certification (EPA June 3, 1999).*

10 *The CBFO is the revising and approving authority for the NDA PDP and plans. The CBFO*
11 *uses the PDP as part of the assessment and approval process for measurement facilities*
12 *supplying characterization services for the NDA of TRU wastes intended for disposal at WIPP.*
13 *The NDA PDP is similar to a blind sample program. The NDA PDP plans use 55-gallon*
14 *drums or SWB's with simulated waste matrix and source standards. The NDA plans identify*
15 *the elements that comprise the program, the criteria used to evaluate NDA system*
16 *performance and the responsibilities of the program participants. The PDP NDA plans are*
17 *revised as required. NDA analysis of drums or boxes is performed by measurement systems*
18 *that have demonstrated acceptable PDP performance.*

19 ~~The Performance Demonstration Program (PDP) plan for NDA for the TRU Waste~~
20 ~~Characterization Program (DOE 1995a) is designed to help ensure compliance with the QAOs~~
21 ~~identified in the TRU Waste Characterization QAPP for the WIPP. This plan, as well as the~~
22 ~~radioassay portion of the current revision of the QAPP, defines QAOs and measurement~~
23 ~~requirements for the characterization of alpha-emitting TRU isotopes associated with weapons-~~
24 ~~grade (WG) plutonium. WG plutonium is selected because of its predominance in an isotopic~~
25 ~~mixture within the TRU waste generated and retrievably stored across the DOE complex.The~~
26 ~~CAO is the reviewing and approving authority for the PDP. All DOE facilities intending to~~
27 ~~dispose of their TRU waste at the WIPP must participate in the PDP and pass all individual tests~~
28 ~~within each PDP cycle. The CAO uses the PDP plan to assess, evaluate, and approve DOE~~
29 ~~facilities for waste measurement and characterization before the waste is shipped to the WIPP~~
30 ~~facility. This approval process also includes the evaluation of method performance data~~
31 ~~submitted by the measurement facility and the performance of QA audits.~~

32 ~~The PDP plan describes the detailed elements that comprise the program, including the test~~
33 ~~materials and the analysis required. The PDP plan also identifies the criteria used for the~~
34 ~~evaluation of laboratory performance and the responsibilities of the program coordinator, the~~
35 ~~standard preparation team, and the participating laboratories. The radioactive source standards~~
36 ~~encompass the range of activities (masses) anticipated in actual waste characterization. The~~
37 ~~PDP sample standards address activity ranges relative to WIPP WAC limits, QAPP QAOs,~~
38 ~~and/or NDA method detection limits (DOE 1995a). The isotopes analyzed under this program~~
39 ~~plan include but are not limited to ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am.~~

40 ~~In conjunction with the source standards, the 55-gallon drums used in the PDP also contain~~
41 ~~manufactured matrix inserts. These matrix inserts simulate waste matrix conditions and provide~~
42 ~~acceptable consistency in the sample preparation process at each measurement facility. For the~~

1 ~~first PDP cycle, the sample 55-gallon drums contain either no matrix material or a benign~~
2 ~~material.~~

3 ~~Laboratory performance must be demonstrated by the successful analysis of blind samples by all~~
4 ~~participating measurement facilities on a semiannual basis. The blind samples (called PDP~~
5 ~~samples) are prepared twice during a calendar year at approximately six-month intervals. The~~
6 ~~PDP samples are analyzed using the methods the measurement facility anticipates using for the~~
7 ~~analysis of WIPP wastes. These methods must have been developed and approved within the~~
8 ~~specifications of the QAPP. Only the methods actually used in the PDP are considered~~
9 ~~acceptable to support the analysis of WIPP wastes. The data generated as a result of the~~
10 ~~performance demonstration indicate the appropriateness of the method used as well as the~~
11 ~~performance of the measurement facility. The program coordinator uses a set of standards that~~
12 ~~encompasses the range of WG material anticipated in actual WIPP waste.~~

13 ~~The measurement facility analyzes the contents of each PDP sample using the procedures in the~~
14 ~~WIPP waste characterization program. The scoring system for the PDP is a pass-fail system. To~~
15 ~~pass a specific test, the measurement must fall within the specified QAOs of the QAPP. To pass~~
16 ~~the PDP cycle, the measurement must pass all individual tests. The scoring system of the PDP~~
17 ~~ensures that the QAOs are satisfied at the 95-percent confidence level.~~

18 ~~Waste analyses may be performed only by measurement facilities that have demonstrated~~
19 ~~acceptable performance in the PDP. Measurement facility performance is used to assess general~~
20 ~~problems that may affect the facility's ability to analyze total alpha activity within a 55-gallon~~
21 ~~waste drum. Identified problems are resolved in accordance with the established QA program.~~

22 **4.4   Waste Characterization**

23 The process of waste characterization identifies the ***significant*** physical, chemical, and
24 radiological properties of the waste using a variety of methodologies. ~~(DOE 1995e), including~~
25 ~~acceptable knowledge, headspace gas sampling and analysis, solid waste sampling and analysis,~~
26 ~~visual examination, NDA, and nondestructive examination (NDE).~~ The measured waste
27 properties obtained by the ***TRU waste*** ~~generator and storage~~ sites are either on a ~~waste~~ container
28 or waste stream basis and serve to demonstrate compliance with the limits imposed by
29 transportation requirements (DOT), ***the Type B package certificate of compliance, the***
30 ***Hazardous Waste Facility Permit (HWFP),*** and operational safety requirements (DOE). In
31 contrast, the waste component limits described in Appendix WCL are on a repository basis and
32 serve as an upper bound for the accumulative waste inventory. As described in Section 4.3.2, the
33 linkage between the collective waste inventory and the repository limits is provided by the
34 WWIS.

35 Recognizing that the ***CH-TRU*** WAP ***and the CH-TRU WAC provide*** ~~establishes~~ the ~~TRU~~
36 ~~mixed~~ waste characterization requirements for ~~DOE~~ waste destined for the WIPP, it is necessary
37 to understand the complementary role played by the radiological characterization of ~~TRU~~ waste.
38 Figure 4-***4***~~7~~ shows the requirements hierarchy governing the characterization of ~~TRU~~ waste for
39 purposes of transportation, disposal, and long-term regulatory compliance. The implementation
40 of waste characterization occurs on a waste-stream basis at the lowest tier of the diagram through
41 the Standard Operating Procedures (SOPs). The next higher tier of Figure 4-***4***~~7~~ includes the ***CH-***
42 ***TRU*** WAC, followed by progressively higher-tier requirements~~, including this application~~. The
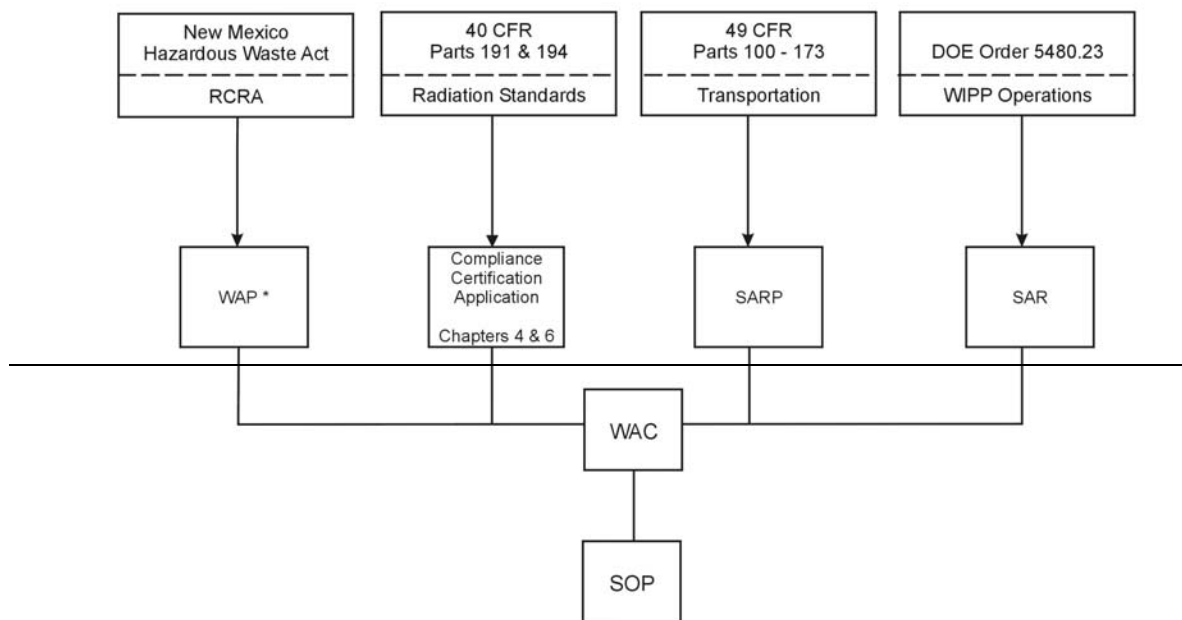
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                                                                    * Chapter C of Part B of the WIPP RCRA Permit Application
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1

2   **Figure 4-7. ~~Requirements Hierarchy of TRU Waste Characterization for~~**
3   **~~Transportation and Disposal~~**

4   waste characterization requirements for compliance with the EPA's regulations ~~pertaining to the~~
5   ~~identification of the disposed waste's hazardous and radiological components~~ are implemented
6   by the SOPs.

7   The WAP includes requirements ***necessary for compliance with the New Mexico Hazardous***
8   ***Waste Act*** ~~for the determination of the physical and chemical properties of CH-TRU and RH-~~
9   ~~TRU mixed waste streams~~ — specifically the identification and quantification of their hazardous
10   components (see ~~Appendix~~ ***Attachment B of the*** WAP ***[NMED 2002]***). A combination of five
11   waste characterization methodologies is employed by the WAP and includes acceptable
12   knowledge, radiography, visual examination, headspace gas sampling and analysis, and
13   solidified waste sampling and analysis. The capabilities and applicabilities of these five
14   methodologies to TRU mixed waste are discussed in considerable detail in the WAP. ~~and the~~
15   ~~QAPP.~~ Except for a brief overview of acceptable knowledge, radiography, and visual
16   examination, a description of the five waste characterization methodologies ***presented in the***
17   ***WAP*** will not be repeated in this document. Radiological characterization of TRU waste is
18   needed for compliance demonstrations to 40 CFR Parts 191 and 194. A quantitative
19   determination of the radionuclides listed in ~~Table 4-10~~ ***Table 4-11*** ~~is driven by~~ ***results from*** the
20   need to demonstrate compliance with the release limits as specified in Appendix A to ~~40 CFR~~
21   Part 191~~, Subpart B~~ and the RH-TRU waste curie limit established by the LWA (see Table
22   4-1**2**~~1~~).

```
                          ┌─────────────────┐
                          │   40 CFR 194    │◄──────────────────┐──────────────┐
                          └─────────────────┘                   │              │
                                   │                            │              │
                                   ▼                            │              │
                          ┌─────────────────┐                   │              │
                          │  NQA 1, 2, & 3  │                   │              │
                          └─────────────────┘                   │              │
                                   │                            │              │
                                   ▼                            ▼              ▼
 ┌─────────────────┐      ┌─────────────────┐      ┌─────────────────┐  ┌─────────────────┐
 │  NRC & DOE QA   │─────►│   DOE/CBFO      │      │ Waste Acceptance│  │  Waste Analysis │
 │  Requirements   │      │ Quality         │      │  Criteria (WAC) │  │  Plan (WAP)     │
 └─────────────────┘      │ Assurance       │      └─────────────────┘  └─────────────────┘
                          │ Program         │
                          │ Document (QAPD) │
                          └─────────────────┘
                                   │
                                   ▼
                          ┌─────────────────┐
                          │ Site Program    │
                          │ Documents       │
                          └─────────────────┘
                                   │
                                   ▼
                          ┌─────────────────┐
                          │ Standard        │
                          │ Operating       │
                          │ Procedures      │
                          │ (SOPs)          │
                          └─────────────────┘
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1
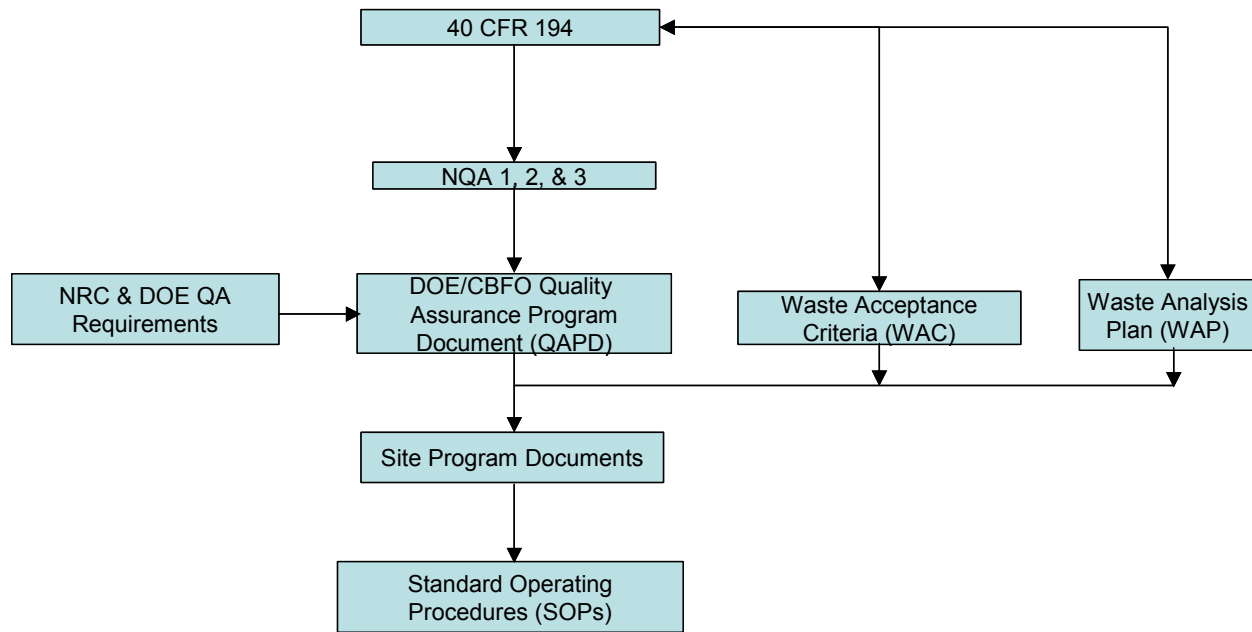
2   *Figure 4-4. Program QA Document Hierarchy*

3   Collectively, those elements of the waste characterization program that support long-term
4   regulatory compliance include the determination of the radionuclide inventory (for purposes of
5   normalizing radionuclide releases as required for comparison with ~~40 CFR §~~ *Section*191.13(a)),
6   the identification of the physical and chemical waste form inventories (if applicable), and the
7   verification that no wastes are emplaced in the WIPP that exceed the disposal system's safety
8   and/or performance limitations.

9   In a manner analogous to the WAP, the WIPP waste radioassay characterization program is
10 conducted by ~~generator and storage~~ *TRU waste* site personnel and is implemented in accordance
11 with the requirements of the ~~QAPP and the~~ *CH-TRU* WAC. ~~A description of the approved~~
12 ~~waste characterization methodologies and QAOs is provided in the QAPP. Generator and~~
13 ~~storage~~ *TRU waste* sites may propose alternative characterization ~~methodologies~~ *methods*, either
14 because of the availability of newer technologies offering enhanced performance or the
15 modification of older technologies to facilitate meeting the ~~QAOs~~ *requirements of Appendix A*
16 *of the CH-TRU WAC*. In these instances, method performance must be demonstrated and
17 approved *in accordance with Section 194.8* prior to its use in characterization *of* TRU waste for
18 disposal at the WIPP.

19 Implementation of the TRU waste characterization program at DOE *TRU waste* sites requires
20 that all waste characterization activities be conducted in accordance with approved
21 documentation that describes the management, operations, and QA aspects of the program.
22 Conformance with applicable regulatory, programmatic, and operational requirements is
23 monitored by ~~CAO~~ *CBFO* audits and surveillances. Refer to *Chapter 5 and CCA* Appendix
24 QAPD ~~and Sections 3.2.3 and 3.2.4~~ for a more detailed discussion of the ~~CAO~~ *CBFO* audit and
25 surveillance program. The documentation requirements important to the implementation of the
26 TRU Waste Characterization Program at each *TRU waste* site are briefly discussed below.

- QA requirements. Implementation of individual site-specific waste certification and characterization programs must meet the QA requirements contained in the ~~CAO~~ *CBFO* QAPD, which are traceable to the applicable sections of ASME NQA-1 through NQA-3 (ASME 1989a, *1989*b, and *1989*c in the ~~Bibliography~~*References*). The *WAP and the CH-TRU WAC* ~~QAPP~~ describe~~s~~ the specific *QA objectives (*QAOs*)* for the TRU Waste Characterization Program. The *WAP and the CH-TRU WAC* ~~QAPP and its associated document, the TRU Waste Characterization Sampling and Analysis Methods Manual~~, delineate approved analytical methods for meeting regulatory requirements.

- QAPjPs. ~~Generator~~ *TRU waste* sites prepare site-specific QAPjPs that describe waste characterization activities in support of the TRU waste characterization program. These documents, developed in accordance with the applicable requirements in the ~~CAO~~ *CBFO* QAPD *and the WAP,* ~~and the QAPP,~~ define QA management and program elements that provide for planning, implementation, and assessment of the TRU waste characterization data-collection activities.

- SOPs. The ~~QAPP~~ *QAPD* requires that each DOE *TRU waste* site develop, implement, and control written SOPs that provide detailed descriptions of routine, standardized, or critical waste characterization activities. The SOPs serve as the basis for quality assessments of waste characterization activities at the site level because they provide detailed descriptions of required activities.

- PDPs. Analytical facilities characterizing waste for disposal at the WIPP must successfully participate in the applicable portions of the PDP. The PDP supports the determination of a facility's ability to meet the QA ~~objectives~~*requirements* identified in the *CBFO QAPD* ~~QAPP~~. A more detailed description of the PDP can be found in Section 4.3.3.1.

As the ~~generator~~ *TRU waste* sites complete the necessary program documentation, they commence waste characterization activities. Information derived from these activities is on a waste-stream basis and is used in preparing the site's waste-stream profile forms required for waste acceptance at the WIPP. The waste characterization data are electronically backed-up in databases at the ~~generator~~ sites and downloaded into the WWIS database (DOE 1996b). The WWIS is described in Section 4.3.2.

~~Generator and storage~~ *TRU waste* sites prepare documented and approved programs controlling their TRU waste characterization, certification (which includes characterization), and transportation processes. Site-specific TRU waste certification plans document how compliance with the *CH-*WAC ~~and QAPP are~~*is* accomplished. Site certification ~~shall be~~ *is* granted by the ~~CAO~~ *CBFO* manager ~~contingent~~ upon ~~final~~ approval of the following documentation:

1. TRU waste certification plan (including QA),

2. QAPjP(s),

3. *NRC Type B packaging methods for payload compliance* TRU package transporter, Model 2 (TRUPACT II) Authorized Methods for Payload Compliance,

1. 4. pPackaging QA plan, and

2. 5. pPerformance in applicable PDPs.

3. In addition to approval of this site-specific documentation, ~~generator and storage~~ *TRU waste*
4. sites must pass an initial *TRU waste* site certification audit where adequate and effective
5. implementation of these programs is assessed (see Sections 5.1~~1~~ and 5.3.19). *Also, as described*
6. *in Section 4.1.2, EPA approval of QA program documentation and implementation is also*
7. *required.*

8. Each ~~TRU~~ waste ~~generator and storage~~ site that is characterizing TRU waste ~~to the requirements~~
9. ~~of the QAPP and the WAC~~ is recertified by the ~~CAO~~ *CBFO* annually. A recertification consists
10. of reviewing (if applicable)*:*

11. 1. sSite-specific program documents that are written and approved to the latest *CH-TRU*
12. WAC~~,~~*;*

13. 2. pProgram implementation as determined by a *TRU waste* site certification audit~~,~~*;*

14. 3. rReports from surveillances conducted during the past year~~,~~*;*

15. 4. pPerformance in shipping TRU waste to the WIPP~~,~~*;* and

16. 5. pPerformance in the PDPs.

17. To ensure that ~~the~~ DOE ~~generator and storage~~ *TRU waste* sites comply with the WIPP TRU
18. waste certification program, audits are conducted by the ~~CAO~~ *CBFO*. An initial audit is
19. conducted at each ~~generator~~ *TRU waste* site performing waste characterization activities prior to
20. the formal acceptance of the waste-stream profile forms and/or any waste characterization data
21. supplied by *TRU waste* site personnel. This formal acceptance is referred to as *TRU waste* site
22. certification. Audits are performed at least annually thereafter, including the possibility of
23. unannounced (not regularly scheduled) audits. These audits verify that the ~~generator~~ site has
24. implemented a QA program for all certification activities. The accuracy of the physical waste
25. description and the subsequent waste stream assignment are verified by a review of acceptable
26. knowledge documentation, radiography data, and visual examination results (if applicable).
27. Table 4-1*6*~~3~~ summarizes the characterization requirements and methods detailed in the *CH-TRU*
28. WAC *and the WAP* that support this application. *The EPA often observes the DOE audits in*
29. *fulfilling its obligations defined in Section 194.8 (see Section 4.1.2).*

30. *Additional information regarding RH-TRU waste characterization has been developed by*
31. *DOE and has been submitted to the EPA (letter from DOE to EPA December 16, 2002). No*
32. *RH-TRU waste has been shipped to the WIPP at the time of CRA-2004. EPA approval of*
33. *DOE's proposed RH-TRU waste characterization procedure is pending.*

34.

1 **Table 4-*16*3. Applicable CH- and RH-TRU Waste Component Characterization Methods**

Waste Properties	Waste Components	Waste Characterization Methods
Nuclear	Radionuclides	NDA OR previous isotopic distribution from destructive radiochemistry OR previous radioassay data reconciled with ***CH-TRU*** WAC requirements
Physical	ferrous metals nonferrous metals cellulos*ic,* plastic*,* rubber ***materials*** solid components free water humic substances	radiography with statistical selection for visual examination OR visual examination and documentation of container content at time of waste packaging for newly generated waste OR documentation and verification (random sampling) for newly generated waste
Chemical	sulfates nitrates organic ligands	No upper or lower limits apply to these chemicals; therefore no waste characterization methods are applied.

2 *4.4.1   Qualitative Methodologies*

3 The criteria at 40 CFR § *Section* 194.24(a) state that *require* a description of the physical,
4 chemical, and radiological composition of the TRU waste to be emplaced in the WIPP disposal
5 system be provided. With regard to the waste's nonhazardous physical and chemical
6 components (such as cellulosic ***materials***), there are three qualitative methodologies, used either
7 singularly or in combination, for verifying adherence to the compliance limits. contained in
8 Appendix WCL. These methodologies include acceptable knowledge, nonintrusive examination
9 using penetrating radiation such as X-ray (referred to as either RTR, radiographic examination,
10 radiometric examination, or ***nondestructive examination (***NDE***)***), and intrusive visual
11 examination consisting of opening the container and recording the contents. ***The use of***
12 ***Acceptable Knowledge information is presented in the WAP and the CH-TRU WAC.***

13 4.4.1.1   Acceptable Knowledge

14 The following discussion is responsive to the *discusses compliance with* criteria at 40 CFR §
15 *Section* 194.24(c)(3).

16 Acceptable knowledge is defined in the EPA Guidance Manual (EPA 1994) in the Bibliography.
17 Acceptable knowledge includes information regarding the physical form of the waste, the base
18 materials composing the waste, and the process that generates*d* the waste. Waste
19 characterization will be used to confirm acceptable knowledge information. ***The WAP and the***
20 ***CH-WAC provide details regarding the application of acceptable knowledge.***

1 Consistency among DOE *TRU waste* sites in using acceptable knowledge information to
2 characterize TRU waste involves a three-phase process: (1) compiling the minimum acceptable
3 knowledge documentation in an auditable record, (2) confirming acceptable knowledge
4 information, and (3) auditing acceptable knowledge records.

5 ~~Appendix WAP, Figure C9-1 illustrates~~ provides an overview of the process for assembling
6 ~~acceptable knowledge documentation into an auditable record. The first step is to assemble all of~~
7 ~~the mandatory acceptable knowledge information and any supplemental information regarding~~
8 ~~the materials and processes that generate a specific waste stream. DOE sites must ensure the~~
9 ~~following criteria are met in establishing acceptable knowledge records:~~

10 - ~~Acceptable knowledge information must be compiled in an auditable record, including a~~
11   ~~road map for all applicable information.~~

12 - ~~The overview of the facility and TRU waste management operations in the context of the~~
13   ~~facility's mission must be correlated to specific waste stream information.~~

14 - ~~Correlations between waste streams, with regard to time of generation, waste generating~~
15   ~~processes, and site-specific facilities must be clearly described.~~

16 Acceptable knowledge documentation provides qualitative information that cannot be assessed
17 according to specific data quality objectives that are used for analytical techniques. QAOs
18 ~~objectives~~ for analytical results are described in terms of precision, accuracy, completeness,
19 comparability, and representativeness. Analytical results will be used to confirm the
20 characterization of wastes based on acceptable knowledge.

21 ~~To ensure that the acceptable knowledge process is consistently applied, sites must comply with~~
22 ~~the following data quality indicators for acceptable knowledge documentation.~~

23 - ~~Precision – Precision is the agreement among a set of replicate measurements without~~
24   ~~assumption of the knowledge of a true value. The qualitative determinations, such as~~
25   ~~compiling and assessing acceptable knowledge documentation, do not lend themselves to~~
26   ~~statistical evaluations of precision.~~

27 - ~~Accuracy – Accuracy is the degree of agreement between an observed sample result and~~
28   ~~the true value. The percentage of waste containers that require reassignment to a new~~
29   ~~WMC will be reported as a measure of acceptable knowledge accuracy.~~

30 - ~~Completeness – Completeness is an assessment of the number of waste streams or~~
31   ~~number of samples collected to the number of samples determined to be useable through~~
32   ~~the data validation process. The acceptable knowledge record must contain 100 percent~~
33   ~~of the required information (see Section C9-3 in Appendix WAP). The useability of the~~
34   ~~acceptable knowledge information will be assessed for completeness during audits.~~

35 - ~~Comparability – Data are considered comparable when one set of data can be compared~~
36   ~~to another set of data. Comparability is ensured through sites meeting the training~~
37   ~~requirements and complying with the minimum standards outlined for procedures that are~~
38   ~~used to implement the acceptable knowledge process.~~

1 • ~~Representativeness—Representativeness expresses the degree to which sample data~~
2 ~~accurately and precisely represent characteristics of a population. Representativeness is a~~
3 ~~qualitative parameter that will be satisfied by ensuring that the process of obtaining,~~
4 ~~evaluating, and documenting acceptable knowledge information is performed in~~
5 ~~accordance with the minimum standards listed in Section C9-4 contained in Appendix~~
6 ~~WAP. Sites also must assess and document the limitations of the acceptable knowledge~~
7 ~~information.~~

8 The acceptable knowledge process and waste stream documentation must be evaluated through
9 internal assessments by ~~quality assurance~~ *QA* organizations and assessments by auditors external
10 to the organization (that is, the ~~CAO~~ *CBFO*).

11 The ~~CAO~~ *CBFO* ~~will~~ *has conducted and will continue to* conduct an initial audit of each
12 ~~generator and storage~~ *TRU waste* site prior to certifying the *TRU waste* site for shipment of TRU
13 waste to the WIPP facility (see ~~Figure C9-2 in Appendix WAP~~ *the Hazardous Waste Facility*
14 *Permit [NMED 2002] Attachment B through B6, including Figure B4-3*). This initial audit
15 will establish an approved baseline that will be reassessed annually.

16 ~~Audit plans will identify the scope of the audit, requirements to be assessed, participating~~
17 ~~personnel, activities to be audited, organizations to be notified, applicable documents, and~~
18 ~~schedule. Audits will be performed in accordance with written procedures and checklists. The~~
19 ~~audit checklists will include specific items associated with the compilation and evaluation of the~~
20 ~~required acceptable knowledge information.~~
21 ~~Audit checklists must include all of the following elements for review during the audit:~~

22 • ~~Documentation of the process used to compile, evaluate, and record acceptable~~
23 ~~knowledge is available and implemented;~~

24 • ~~Personnel qualifications and training are documented;~~

25 • ~~Required acceptable knowledge documentation has been compiled in an auditable record;~~

26 • ~~A procedure exists for resolving inconsistencies in acceptable knowledge documentation;~~

27 • ~~A procedure exists for confirming acceptable knowledge information; and~~

28 • ~~Results of other audits of the TRU waste characterization programs at the site are~~
29 ~~available in site records.~~

30 ~~Members of the audit team will be knowledgeable regarding the required acceptable knowledge~~
31 ~~information regarding the use of acceptable knowledge for waste characterization. Audit team~~
32 ~~members will be independent of all TRU waste management operations at the site being audited.~~

33 ~~Auditors will evaluate documents associated with the evaluation of the acceptable knowledge~~
34 ~~documentation for at least one debris waste stream and one solidified waste stream during the~~
35 ~~audit. For these waste streams, auditors will review procedures and associated processes~~
36 ~~developed by the site for documenting the process of compiling acceptable knowledge~~

1 ~~documentation; correlating information to specific waste inventories; and identifying, resolving,~~
2 ~~and documenting discrepancies in acceptable knowledge records. The adequacy of acceptable~~
3 ~~knowledge procedures and processes will be assessed and any deficiencies in procedures~~
4 ~~documented in the audit report.~~

5 ~~Auditors will review the acceptable knowledge documentation for selected waste streams for~~
6 ~~logic, completeness, and defensibility. The criteria that will be used by auditors to evaluate the~~
7 ~~logic and defensibility of the acceptable knowledge documentation include completeness and~~
8 ~~traceability of the information, consistency of application of information, clarity of presentation,~~
9 ~~degree of compliance with Appendix C9 of the WAP with regard to acceptable knowledge~~
10 ~~confirmation data, nonconformance procedures, and oversight procedures. Auditors will~~
11 ~~evaluate compliance with written site procedures for developing the acceptable knowledge~~
12 ~~record. A completeness review will evaluate the availability of the minimum required TRU~~
13 ~~waste management and TRU waste stream information. Records will be reviewed for correlation~~
14 ~~to specific waste streams. Auditors will verify that sites include all required information. All~~
15 ~~deficiencies in the acceptable knowledge documentation will be included in the audit report.~~

16 ~~Auditors will verify and document that sites use administrative controls and follow written~~
17 ~~procedures to make waste determinations for newly generated and retrievably stored wastes.~~
18 ~~Auditors will review procedures used by the sites to confirm acceptable knowledge information.~~

19 ~~After the audit is complete, the CAO will provide the site with preliminary results at a close-out~~
20 ~~meeting. The CAO will prepare a final audit report that includes all observations and findings~~
21 ~~identified during the audit. Sites must respond to all audit findings and identify corrective~~
22 ~~actions. Audit results will be available at CAO for review by regulatory agencies, and copies~~
23 ~~will be provided upon request. If acceptable knowledge procedures do not exist, the minimum~~
24 ~~required information is not available, or significant findings of noncompliance are identified, the~~
25 ~~CAO will not grant the site waste characterization and certification authority for the subject~~
26 ~~waste. Waste stream characterization and certification authority may be revoked or suspended if~~
27 ~~there are significant findings during subsequent annual audits.~~

28 ~~Prior to notifying a site that a waste stream can be shipped and accepted at the WIPP facility, the~~
29 ~~CAO will review the Waste Stream Profile Forms and associated data packages. Sites must~~
30 ~~provide all of the required data associated with waste steam characterization. The data packages~~
31 ~~will be evaluated as illustrated in Figure C9-2 in Appendix WAP. The CAO will review~~
32 ~~information provided by the sites to ensure that changes to waste codes are identified and~~
33 ~~justified. If data consistently indicates discrepancies with acceptable knowledge information, the~~
34 ~~CAO will require sites to increase sampling, reassess the materials and processes that generate~~
35 ~~the waste, and resubmit waste stream profile information. Until discrepancies are resolved,~~
36 ~~shipment of the waste stream to the WIPP will be prohibited.~~

37 4.4.1.2   <u>Nondestructive Examination</u>

38 NDE is a ~~nondestructive~~ qualitative technique that involves ***the use of*** X-ray***s*** ~~interrogation~~
39 ***examination*** of waste containers to identify and verify the contents. NDE is used to verify the
40 absence of prohibited items and to determine the appropriate methodologies to be used for waste
41 characterization. NDE is not required for newly generated waste because controls exist to verify

1 compatibility of the matrix material(s) and the absence of prohibited items prior to and during
2 waste packaging.

3 ~~A typical NDE system consists of an X-ray producing device, a container handling system, and~~
4 ~~an imaging detector. X-ray generators typically used in NDE produce X-rays ranging in energy~~
5 ~~from under 100 kiloelectron volts up to approximately 450 kiloelectron volts. If higher energies~~
6 ~~are needed, either because of a high-density waste matrix or the need to penetrate shielded~~
7 ~~payload containers, then the use of a linear accelerator becomes a viable approach for producing~~
8 ~~a pulsed X-ray beam with energies to 25 megaelectron volts and beyond.~~

9 ~~The X-ray detector has the function of converting the radiation input signal into a corresponding~~
10 ~~optical or electronic output signal that ultimately is used to reconstruct an image of the payload~~
11 ~~container contents. An example of a system presently in use at many of the generator and~~
12 ~~storage sites is RTR, which gives the operator the opportunity to view events in progress (that is,~~
13 ~~in real time). In an RTR system, the imaging system typically utilizes a fluorescent screen and a~~
14 ~~low light television camera (since the light output of most screens is quite low). The resulting~~
15 ~~image is transferred to a remotely located television screen, and the operator conducts the~~
16 ~~examination by viewing the remote television screen.~~

17 ~~Data acquired by NDE are documented as required by the QAPP. The QAOs for radiography, as~~
18 ~~listed in Section 10 of the QAPP, include precision, accuracy, completeness, and comparability.~~
19 ~~Since radiography, the primary methodology for performing NDE, is basically a qualitative~~
20 ~~determination, there is no specification for a method detection limit. The QAOs for NDE using~~
21 ~~radiography are summarized below.~~

22 ~~Precision and Accuracy – The qualitative determinations made during radiography do not readily~~
23 ~~lend themselves to statistical evaluation of precision or accuracy. An estimate of precision and~~
24 ~~accuracy can be made, however, by comparing the results of NDE with the results of visual~~
25 ~~examination of a randomly selected statistical portion of waste containers.~~

26 ~~Completeness – An audiotape or videotape of the radiography examination (or equivalent for~~
27 ~~other NDE methodologies) and a radiography data form, validated according to the requirements~~
28 ~~in Section 3.0 in the QAPP, must be obtained for 100 percent of the retrievably stored waste~~
29 ~~containers.~~

30 ~~Comparability – The comparability of radiography data from different sites shall be enhanced by~~
31 ~~using standardized radiography procedures and operator qualifications. in accordance with the~~
32 ~~requirements of the QAPP.~~

33 All activities required to achieve the radiography objectives must be described in *TRU waste* site
34 QAPjPs and SOPs. Retrievably stored containers will have this type of permanent record on file
35 throughout the life of the WIPP project. As a quality control check on NDE, a statistically
36 determined number of retrievably stored containers within the population subjected to NDE will
37 be randomly selected and visually examined.

1 4.4.1.3   Visual Examination

2 ~~The v~~*V*isual examination ~~technique~~ is used by ~~the~~ DOE to provide an acceptable level of
3 confidence in NDE. There is no equivalent method in the EPA sampling and analysis guidance
4 documents. ~~A detailed procedure that meets the requirements of this method can be found in the~~
5 ~~WIPP Waste Characterization Program Sampling and Analysis Methods Manual (DOE 1995c).~~
6 ~~Generator~~ *TRU waste* site personnel develop training programs that are based on waste form and
7 waste management operations. These training programs are used to assess operator performance.
8 The QAPjPs and supporting SOPs specify the training requirements and other activities required
9 to achieve the visual examination objectives. The visual examination expert must be familiar
10 with the waste generating processes that have taken place at that *TRU waste* site and also with
11 the types of waste being characterized at the site. For an explanation of the hypergeometric
12 approach used in determining the number of containers to be statistically sampled by visual
13 examination, see the *WAP*. ~~Appendix A of the QAPP (DOE 1995b).~~

14 *4.4.2   Quantitative Methodologies*

15 To minimize exposure, the quantitative methodology used to determine the radionuclide
16 inventory of the waste is NDA. The nonintrusive methodology of NDA employs radiation
17 detection techniques for determining the waste's isotopic content and activity. This is the
18 preferred approach because of the safety hazards involved in opening waste containers having
19 radioactive contaminants. Although the data generated by radioassay serve many functions
20 including the calculation of the ^{239}Pu equivalent activity, the ^{239}Pu fissile gram equivalent, and
21 the decay heat of waste containers, the purpose of these data relative to long-term regulatory
22 compliance with 40 CFR Part 191 is to provide corroborative data relating to the radionuclide
23 inventory reported in the ~~TWBIR~~ *CRA-2004* and furnish radionuclide information on a container
24 basis to maintain a running inventory of TRU waste emplaced in the WIPP disposal system.

25 TRU nuclides emit both ionizing radiation (including alpha particles, beta particles, and gamma
26 rays) and nonionizing radiation (neutrons). Based on detection of these emissions, several
27 technologies have been developed to measure one or more of these radiations as they emerge
28 from the waste container. Although most of the ionizing radiation (alpha and beta particles) are
29 not able to penetrate the walls of the waste container, both gamma rays and neutrons can
30 penetrate the waste matrix as well as the waste container to varying degrees. Combining gamma
31 ray measurements, other advanced particle detection techniques specific to neutrons, and
32 acceptable knowledge provides the precision and accuracy required by the QAOs contained in
33 the *CH-TRU WAC Appendix A* ~~QAPP~~. Mass spectroscopy and radiochemistry also provide the
34 precision and accuracy to meet the QAO requirements in the *CH-TRU WAC Appendix A* ~~QAPP~~.

35 Special techniques, instrumentation, and detectors have been developed to measure the gamma
36 ray energies. Because there are many different gamma rays originating from any one
37 radionuclide with each gamma ray having a unique energy and rate of occurrence characteristic
38 of the radionuclide from which it originated, the resulting distribution or spectrum of gamma ray
39 energies provides a fingerprint or signature of that particular radionuclide. In practice, with the
40 application of appropriate correction factors and the utilization of acceptable knowledge, gamma
41 ray and neutron NDA systems provide radioisotope inventory information about the waste
42 without the need for opening the container.

1 All radioassay systems must be calibrated using a variety of matrix and source standards to
2 simulate the various waste compositions, source distributions, and interferences common to the
3 waste streams originating from a particular ~~generator~~ *TRU waste* site. By applying the resulting
4 correction factors to the measurements, an accurate assessment of the radionuclide inventory
5 within the waste container is feasible. NDA methods appropriate to a particular waste stream
6 profile are used in the radionuclide analysis.

7 4.4.2.1   Nondestructive Assay

8 A variety of NDA methodologies are effective in meeting the requirements of the *CH-TRU*
9 *WAC Appendix A* ~~QAPP~~. ~~Table 9-2 of the QAPP identifies a number of such systems that are in~~
10 ~~use at various DOE and/or contractor testing facilities. These~~ *NDA* instruments can be classified
11 as belonging to one or more of the four categories listed below:

12 • gamma ray measurements

13 – low- and high-resolution spectroscopy using a sodium iodide and intrinsic germanium
14 detector, ~~respectfully,~~

15 – transmission-corrected gamma ray measurement using a segmented gamma ray
16 scanner, and

17 – transmission-corrected gamma ray measurement using a computed tomographic
18 gamma ray scanner.

19 • passive neutron measurements

20 – passive neutron coincidence counter,

21 – advanced matrix-corrected passive neutron counter (add-a-source), and

22 – shielded neutron-assay probe totals counter.

23 • passive and active neutron measurements

24 – ~~americium~~*Am*-~~L~~*l*ithium source-driven coincident counter,

25 – californium delayed-neutron counter (shuffler),

26 – neutron generator differential die-away counter, and

27 – combined thermal and epithermal neutron counter.

28 • thermal neutron capture

29 – californium delayed-neutron counter,

30 – neutron generator differential die-away counter, and

1   –   combined thermal and epithermal neutron counter.

2 The list is neither complete nor limiting and is meant to illustrate the breadth of choice available.
3 QAOs may be met with the listed systems or by modifications, functionally equivalent
4 alternatives, multiple combinations, or hybrids of the systems.

5 For each of the radionuclide components identified in Table 4-*11*~~10~~ as being significant to
6 ~~performance assessment~~ *PA* and requiring assay, any of the above NDA methodologies, either
7 singularly or in combination, may be used in determining the activity and corresponding
8 uncertainty. In the case of 100-percent sampling, these measurements are performed on a ~~waste~~
9 container basis. For the case of less than 100-percent sampling, the reported values are on a
10 waste stream basis. Upon receipt of the waste at the WIPP, the measured activity of these
11 significant radionuclide components, plus their associated uncertainty, are accumulated by the
12 WWIS in order to ensure that the volume and activity limits of the repository are not exceeded.

13 *4.4.3   Additional Change to the Waste Characterization Program*

14 *Since the certification of the WIPP, an additional change related to the waste characterization*
15 *program has occurred. In the past, DOE planned to declassify any classified materials in*
16 *waste before shipment to WIPP. In 2002, the RFETS proposed sending waste containing*
17 *classified shapes to WIPP, where the associated radiography and VE records would be*
18 *classified and require a DOE security clearance for review and audit. In 2003, the EPA*
19 *determined that classified waste may be shipped to WIPP provided DOE meets certain*
20 *specified requirements (EPA letter of February 11, 2003, to DOE CBFO).*

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